THE SELF-FEEDER FOR DAIRY CALVES

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The difficulty of securing an adequate supply of competent labor for dairy farms and the large amount of work involved in rearing the calves are two of the factors which have contributed to the adoption by many dairymen of the plan of maintaining the milking herd largely through purchase of cows instead of raising the heifer calves. Since the self-feeder has been employed successfully with other classes of live stock in saving labor as well as in securing rapid and economical gains in live weight, an investigation was undertaken at the Nebraska Experiment Station to determine whether the self-feeder could not be utilized in rearing dairy calves with the object of securing economy of labor and also satisfactorily rapid growth. While it is expected that the investigation will be continued for some time, a portion of the results obtained are considered of sufficient value to warrant a report before completion of the experiment.

GENERAL PLAN OF EXPERIMENT

The length of the feeding period included only the time from the birth of the calves until they became six months of age. It is during this period that most of the difficulties in rearing calves due to indigestion and various other ailments are encountered, and thus the period requiring the closest supervision and the most labor. Calves which are well grown at six months of age require much less attention after that time since they are able to consume enough grain and hay to promote rapid growth.

The calves were separated from their dams at one to three days of age, depending upon the vigor of the calves, and taught to drink milk. They were placed in individual stalls and accurate feed records kept. The amount of milk consumed by the calves while with their dams is not included in the tabulations, since the milk had no commercial value and the amount was dif-

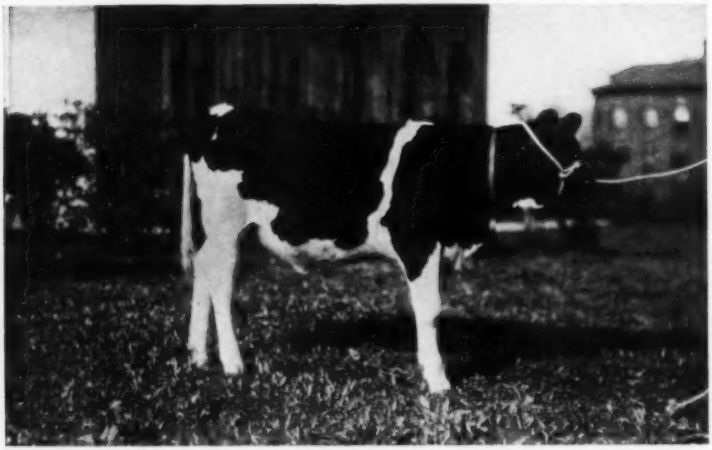

FIG. 1. CALF NO. 1 AT SIX MONTHS OF AGE

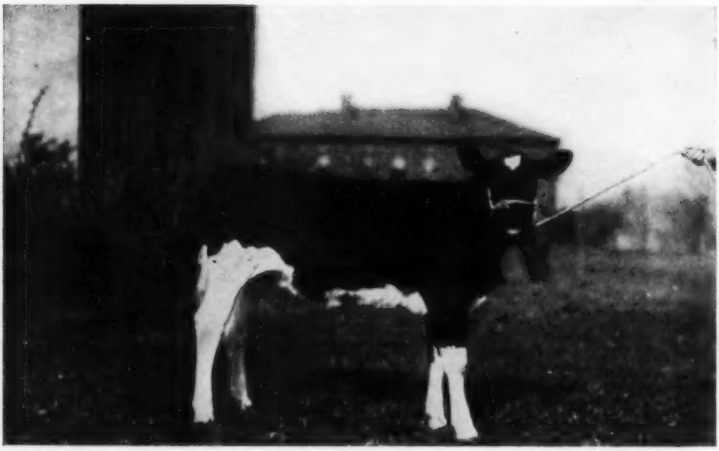

FIG. 2. CALF NO. 2 AT SIX MONTHS OF AGE

difficult to determine. The box stalls in which the "self-fed" calves (lot 1) were kept were provided with hoppers for grain and racks for hay which were kept filled. These calves were kept in the stalls the greater part of the day, being turned out in the morning for one to two hours' exercise. The calves in lot 2 were fed and cared for in a manner similar to that of lot 1, except that grain and hay were supplied in two feeds of each daily, the amounts fed being about what the calves would clean up within a short time.

The calves were weighed weekly and at six months of age photographs and body measurements were taken. All of the calves used in this experiment were pure bred Holsteins, and all but no. 5 were females. Nos. 1 and 3 were by the same sire and nos. 2, 4 and 5 by another sire.

RATIONS USED

The feeds supplied to the calves of the self-feeder lot consisted largely of whole milk until the calves were three weeks of age, when skim milk was gradually substituted for the whole milk. Alfalfa hay and grain were offered at as early an age as the calves would consume them. The amount of skim milk was gradually increased up to 16 pounds daily, which was the maximum amount fed. Skim milk feeding was continued to the end of the experimental period. The grain mixture used until the calves were three months of age consisted of dried beet pulp 3 parts, wheat bran 2 parts and linseed oil meal 2 parts. For the three to six months period it was believed that more bulk would be required in the grain mixture so that the calves would not eat an injurious amount of grain. To accomplish this result two parts of alfalfa meal were added to the above mixture.

The calves in lot 2 received the same feeds as the self-fed calves with the exception of the grain. Nos. 237 and 239 received corn only while nos. 229 and 234 received a mixture consisting of corn 5 parts, bran 2 parts and oil meal 2 parts.

SELF-FED CALVES GREW RAPIDLY

The calves which received grain and hay from the self-feeders consumed very large amounts of feed and made rapid gains in weight. At three months of age the approximate average daily ration consisted of 16 pounds of skim milk, 5 pounds of grain and 1.5 pounds of hay. In spite of the large amount of grain consumed the calves did not attain a degree of fleshiness in excess of that considered desirable in growing calves, but grew rapidly in frame. Before they reached the age of six months,

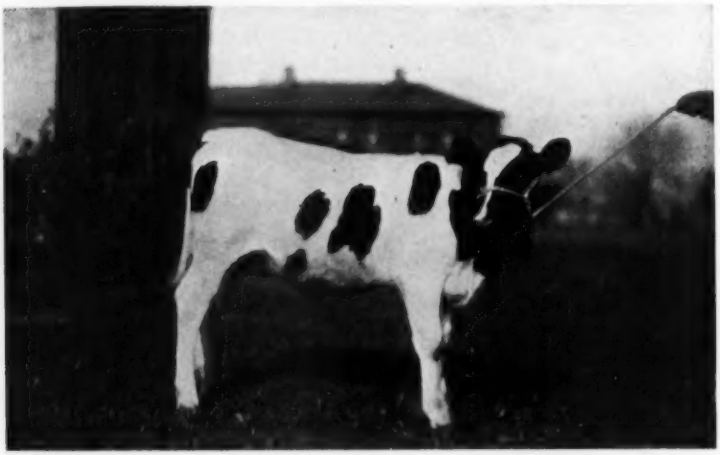

FIG. 3. CALF NO. 3 AT SIX MONTHS OF AGE

however, three of the calves showed a tendency to fatten, due, no doubt, to the excessive amount of grain consumed. The approximate average ration at six months of age consisted of 16 pounds of skim milk, 2 pounds of hay and 10 pounds of grain. There was considerable variation in the amount of hay eaten, nos. 1 and 5 each consuming about 3 pounds daily compared with about 1 pound each for nos. 2 and 4. That the calves which received grain from the self-feeder consumed a much greater amount of grain than those fed in the ordinary manner is evi-

denced by the fact that the calves in lot 1 consumed during the birth to six months period 5.3 pounds of grain per head as a daily average compared with 1.6 pounds for the calves of lot 2. Table 1 contains a record of the feed consumed by each calf.

TABLE 1

Feed consumed by calves from birth to six months of age, grain and hay being fed in self feeders

	NUMBER OF CALF					AVERAGE
	1	2	3	4	5	
	pounds	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*
Whole milk	272.0	190.0	205.0	212.0	220.0	219.8
Skim milk	2475.0	2472.0	2501.0	2470.0	2491.0	2481.8
Alfalfa hay	281.0	162.0	201.0	158.0	282.0	216.8
Alfalfa meal	183.4	160.6	165.6	167.4	161.4	167.7
Dried beet pulp	355.8	317.7	337.8	345.9	328.2	337.1
Bran	237.2	211.8	225.2	230.6	218.8	224.7
Oil meal O. P.	237.2	211.8	225.2	230.6	218.8	224.7
Average pounds grain daily	5.6	4.9	5.2	5.4	5.2	5.3
Total digestible nutrients*	1097.5	946.9	1007.9	998.4	1033.5	1016.8

* Calculated from analyses given in Henry and Morrison's Feeds and Feeding.

TABLE 2

Live weights, gains in weight, and digestible nutrients per pound of gain of self-fed calves from birth to six months of age

	NUMBER OF CALF					AVERAGE
	1	2	3	4	5	
	pounds	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*
Birth weight	112.0	82.0	104.0	88.0	90.0	97.0
Weight at six months	538.0	434.0	488.0	468.0	524.0	490.4
Gain in weight	426.0	352.0	384.0	380.0	425.0	393.4
Daily gain in weight	2.34	1.93	2.11	2.09	2.34	2.16
Digestible nutrients per pound gain	2.58	2.69	2.63	2.63	2.43	2.59

Practically no digestive disturbances were experienced by these calves, and they remained in the best of health and vigor throughout the experimental period.

In table 2 the live weights, gains in weight, and the amount of digestible nutrients required per pound of live weight have been

FIG. 4. CALF NO. 4 AT SIX MONTHS OF AGE

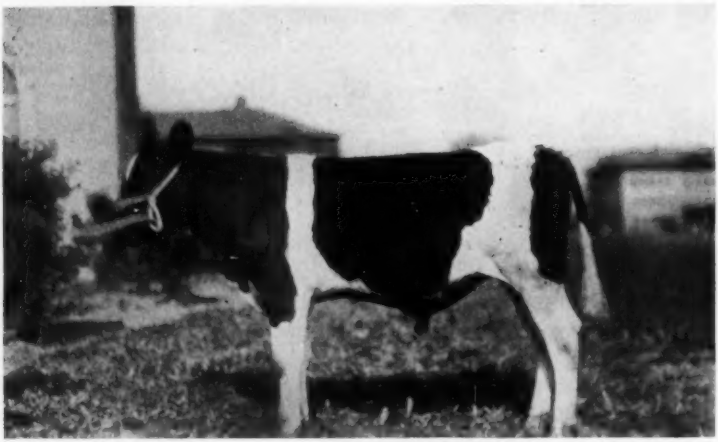

FIG. 5. CALF NO. 5 AT SIX MONTHS OF AGE

recorded. The average birth weight of these calves was somewhat above the average for the breed and considerably greater than that of the calves of lot 2. The gains in weight of these calves were exceptionally large. The average daily gain in weight ranged from 1.93 pounds to 2.34 pounds with an average for the group of 2.16 pounds per head. It is usually considered that a gain of 1 pound daily by a dairy calf is satisfactory and a gain of 1.5 pounds daily very good. The amount of digestible nutrients required to make the remarkable gains of lot 1 was not disproportionate when compared to the amount required under other methods of feeding. The quantity required per pound of gain

TABLE 3

Feed consumed by calves in lot 2 from birth to six months of age

	NUMBER OF CALF				AVERAGE
	237	239	229	234	
	pounds	*pounds*	*pounds*	*pounds*	*pounds*
Whole milk	136.0	151.0	188.0	216.0	172.8
Skim milk	2291.0	2178.0	2588.0	1975.0	2258.0
Alfalfa hay	419.0	324.0	425.0	470.0	409.5
Corn	308.0	299.0	192.2	157.4	239.2
Bran			76.9	62.8	69.9
Oil meal			76.9	62.8	69.9
Average pounds grain daily	1.7	1.6	1.4	1.6	1.6
Total digestible nutrients*	713.0	648.7	760.0	683.0	701.0

* Calculated from analyses given in Henry and Morrison's Feeds and Feeding.

ranged from 2.43 pounds to 2.69 pounds with an average of 2.59 pounds. The calves of lot 2 made their gains somewhat more economically, the average being 2.47 pounds of digestible nutrients per pound of gain.

GOOD GAINS MADE BY LOT 2

The records of the calves in lot 2 were selected for comparison with those of lot 1. The calves in lot 2 were part of those entered in an experiment to determine the food requirements for growth and received a different grain mixture than those of the self-feeder group. However, since the former calves were considered

to have been "heavy fed" their gains in weight and size may be used for comparison. These calves made an average daily gain of 1.55 pounds per head, the range being 1.37 pounds to 1.73 pounds. As mentioned above this is a good rate of increase in live weight, but falls short of the average gain of the self-feeder calves by 0.61 pound daily.

TABLE 4

Live weights, gains in weight and digestible nutrients per pound of gain of calves in lot 2 from birth to six months of age

	NUMBER OF CALF				AVERAGE
	237	239	229	234	
	pounds	*pounds*	*pounds*	*pounds*	*pounds*
Birth weight	78.0	66.0	101.0	80.0	81.3
Weight at six months	357.0	356.0	416.0	330.0	364.8
Gain in weight	279.0	290.0	315.0	250.0	283.5
Daily gain in weight	1.53	1.59	1.73	1.37	1.55
Digestible nutrients per pound gain	2.56	2.24	2.41	2.73	2.47

SIZE OF CALVES AT SIX MONTHS OF AGE

Gain in weight alone is not a sufficient guide for determining whether growth is satisfactory. Increase in the size of the skeleton, proportionate development of the barrel, etc., are also desired. Measurements of the height at the withers, width of the hips and heart girth can be taken accurately and serve as a basis for the comparison of skeleton growth. These combined with the weights give a fair indication of the character of the growth attained. The measurements recorded in table 5 of various groups of calves show that the heavy fed calves of lot 2 were somewhat smaller than heavy fed animals in Eckles' experiment (3) but compared favorably with the standard for the breed under conditions of normal growth as stated by Eckles and Warren (5). The self-fed calves (lot 1) however, were considerably larger both in size of frame and in weight than any of the other groups.

TABLE 5

Comparison of measurements and weights of various groups of Holstein calves

	ECKLES* HEAVY FED GROUP	ECKLES AND WARREN† NORMAL GROWTH	NEBRASKA HEAVY FED GROUP (LOT II)	NEBRASKA SELF FEEDER CALVES (LOT I)
Height at withers, cm	104.4	103.6	103.4	110.6
Width of hips, cm			30.1	32.7
Heart girth, cm			123.1	135.6
Weight, pounds	422.0	350.0	364.8	490.6

* Bul. 135, Mo. Agr. Exp. Sta.

† Dairy Farming, by Eckles and Warren, p. 122.

CONCLUSIONS

It is not expected that the results obtained in feeding as small a number of animals as was the case in that portion of the experiment here reported can be relied upon to definitely establish the self-feeder method of feeding dairy calves as an entirely practicable or improved method of feeding. The results do indicate, however, that calves self fed on grain and hay consume greater quantities of feed and make more rapid growth than those fed under the usual method of two feeds per day. They also indicate that the employment of the self-feeder might effect a material saving in the amount of labor required when feeding calves under practical conditions. The calves raised under the self-feeder plan suffered no ill effects as a result of the system of feeding and at six months of age had every appearance of healthy, vigorous dairy animals.

The self-feeder for dairy calves is a subject deserving further investigation.

RELATION OF THE ENZYMES OF BUTTER TO THE PRODUCTION OF TALLOWINESS BY COPPER SALTS AND OVER-NEUTRALIZATION[1]

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INTRODUCTION

Hunziker and Hosman (1) have shown that one of the most important, if not the chief cause of tallowy butter, is the catalytic action of small quantities of iron or copper lactate formed through the contact of sour cream with rusty creamery utensils or tinned copper vessels in which the copper has become exposed by wear. Experiments carried out by these investigators show that the salts mentioned greatly accelerate the oxidation of certain of the constituents of butter, giving rise to the disagreeable tallowy odor and flavor which makes the product unfit for the market. The experiments indicate, also, that an oleic acid ester of glycollic acid is probably the principal compound formed which is responsible for the tallowy odor and flavor.

The formation of glycollic acid in butter is believed by Hunziker and Hosman to be the result of an oxidation of either lactose or free glycerol, the latter following the hydrolysis of portions of the neutral fat. Inasmuch, however, as rendered butter fat will itself take on certain of the characteristics of tallowy butter, such as the bleaching of the color and the development of the characteristic odor, one is inclined to favor the view that glycerol is the more likely forerunner of the glycollic acid than the lactose.

There can be no controversy, however, regarding the character of the reaction which causes the tallowy decomposition. If further proof is needed that the decomposition is essentially an oxidation, the fact may be cited that the bleaching of the color

[1] An abstract of this paper was presented before the Division of Biological Chemistry at the Philadelphia Meeting of the American Chemical Society, September, 1919.

which accompanies the reaction is the result of the oxidation of the natural carotinoid pigments of butter fat. Most of the artificial butter colors are decolorized similarly on oxidation. In addition, Zilva (2) has recently made the observation that butter which is exposed to the action of ultra violet light rays bleaches entirely and acquires a tallowy odor. That an oxidation occurred in this case is shown by the well-known fact that the ultra violet light rays produce ozone from atmospheric oxygen.

Zilva made the further observation that his bleached butter had lost its fat-soluble vitamine, a fact of considerable importance to the biologists who are interested in the properties of this vitamine.

Our attention was attracted to the problem of tallowy butter largely from the standpoint of the chemical changes which bring about this decomposition. It seemed to us that if oleic acid and glycerol are the most probable forerunners of the glycollic acid ester which Hunziker and Hosman believe to be the direct cause of the tallowy odor and flavor, a certain amount of fat hydrolysis must precede the oxidation and esterification which culminate in the tallowy compound. According to this view hydrolysis is just as essential as oxidation to the decomposition and the agents in cream and butter which cause hydrolysis of the fat may be factors of great importance in connection with the production of the tallowy butter. Whether such agents are natural to the cream or are the result of bacterial or mold secretion is not a question of importance in this connection.

The experiments which are reported in this paper were carried out for the purpose of studying the relative importance of hydrolytic enzymes in cream and butter in connection with the production of tallowiness.

EXPERIMENTAL

In Hunziker and Hosman's experiments the samples of butter containing the metallic salts were built up by emulsifying melted butter fat with curd solutions containing the metallic salts. We imitated practical conditions more closely in our experiments by adding the metallic salt to the cream and observing the changes in the butter churned from the cream.

We were not concerned in these experiments with determining the minimum quantities of metallic salts required to bring about tallowiness. The plan was to add sufficient amounts to insure tallowiness in the butter produced, and to use the same proportion of metallic compound in each experimental churning.

Amount and kind of metallic salt used. Hunziker and Hosman do not state the proportion of metallic salts which they used to bring about tallowiness. Their results showed clearly, however, that copper is a more active oxidizing agent than iron. We accordingly chose copper lactate for our experiments and arbitrarily added 5 cc. of a 3.25 per cent solution of $Cu(C_3H_5O_2)_2$, $2H_2O$, or 0.163 gram, to each quart of cream. This would be a concentration of about 0.017 per cent copper lactate. This amount was sufficient to cause tallowiness in all the cases studied. Rogers and his co-workers (3) added 1, 1.5, 2.5 and 5 mgm. of copper lactate per kilo to respective samples of cream, but did not report any cases of tallowiness on storage of the butter produced from this cream. The largest amount of copper lactate which they added was, of course, very much smaller than 0.017 per cent.

General plan of study. Three experiments were carried out along the same general lines. In each case a batch of fresh raw cream was standardized to 25 per cent fat and divided into two equal parts. One part was handled in the raw condition throughout and the other part was pasteurized at 79° to 80°C. for fifteen minutes. The temperature of pasteurization employed has been shown by Rogers (4) to effectively destroy all but the proteolytic enzymes in milk. Quart portions of the raw and pasteurized samples were then treated with copper lactate solution, 5 per cent of good starter added and the creams churned after ripening for twenty-four hours at 21°C. Other quart portions of the raw and pasteurized creams were ripened without the addition of copper lactate, brought to strongly alkaline condition with NaOH, using phenolphthalein as indicator, neutralized with lactic acid, treated with copper lactate, fresh starter added, and churned after a second period of ripening.

The samples were churned in most cases in small Dazey churns. The butter was washed twice, worked uniformly, salted, wrapped in parchment paper, placed in cardboard cartons, and kept under a bell jar for observation at stated intervals. In experiments 1 and 2 the samples were kept at room temperature. In experiment 3 a double portion of cream was used in each churning, the butter divided, and part kept at room temperature and part in the refrigerator at 8° to 10°C.

No provision was made in experiment 1 for check samples of raw and pasteurized cream which had not been treated with copper. Check samples were prepared, however, in experiments 2 and 3.

Considerable mold growth was encountered in experiments 1 and 2. This was effectively prevented in experiment 3 by placing a few cubic centimeters of ethyl alcohol in a dish under the bell jar with the cartons containing the butter. Alcohol vapor is an efficient poison towards the growth of the mold usually found on butter.

The results of the three experiments are given in tables 1, 2 and 3.

DISCUSSION OF RESULTS

The results in each of the three experiments are uniform in showing a more rapid development of the tallowy decomposition in the raw cream butter than in the butter made from cream in which the enzymes had been largely destroyed by pasteurization at a high temperature. The fact that tallowiness developed eventually, however, even in the samples from the pasteurized cream may be interpreted in several ways. From one point of view the results may be interpreted as indicating that the hydrolytic enzymes of butter are partially responsible for the production of the tallowy decomposition but are not of sufficient importance that their absence prevents the decomposition entirely. On the other hand, it is well known that milk contains very active oxidizing enzymes which are inactivated at the temperature of pasteurization used in these experiments. The difference between the time of development of tallowiness in the raw and pasteurized

TABLE 1

Influence of pasteurization on production of tallowy butter by copper lactate and over-neutralization, butter made December 19–21, 1918, kept at room temperature

SAMPLE NUMBER	CHARACTER OF SAMPLE	OBSERVATIONS ON BUTTER				
		December 21	December 30	January 6	January 16	January 20
1	Raw + copper	Slightly metallic	Normal*	Normal*	Strongly tallowy	Entirely bleached†
2	Pasteurized + copper	Slightly metallic	Normal*	Normal	Slightly bleached on surface	Partly bleached
3	Raw, over-neutralized + copper	Normal	Normal	Off flavor	Strongly tallowy	Entirely bleached
4	Pasteurized, over-neutralized + copper	Slightly off flavor	Normal	Normal	Slightly bleached on surface	Partly bleached

* The term normal in these columns indicates that no tallowiness had developed.

† In all cases bleaching was accompanied by the characteristic tallowy odor. Bleaching of the carotin began on the surface and slowly penetrated the interior.

TABLE 2

Influence of pasteurization on production of tallowiness in butter made February 10–12, 1919, kept at room temperature

SAMPLE NUMBER	CHARACTER OF SAMPLE	OBSERVATIONS ON BUTTER					
		February 12	March 12	March 17	March 28	April 26	May 19
1	Raw, check	Normal	Rancid but not tallowy	No change	Very rancid but no bleaching or tallowiness	No tallowiness, very rancid	Very rancid and cheesy, but not bleached
2	Pasteurized, check	Normal	Normal	Normal	Off flavor, but not tallowy	Very rancid, not bleached	Very rancid and cheesy, but not bleached
3	Raw + copper	Normal	Tallowy	Very tallowy	Very tallowy	Sample turned brown	
4	Pasteurized + copper	Normal	Normal	Normal	Slightly bleached	About ¼ bleached†	
5	Raw, over-neutralized + copper	Cheesy*	Slightly bleached	Tallowy	Very tallowy	Sample turned brown	
6	Pasteurized, over-neutralized + copper	Normal	Normal	Normal	Slightly bleached	About ¼ bleached	

* The cheesy flavor in the fresh sample was probably due to the difficulty in ripening the cream after over-neutralization, giving an opportunity for putrefying bacteria to develop in the raw cream.

† Bleaching began on the surface and slowly penetrated towards the center of the cake. Samples 3, 4, 5 and 6 were discarded at this date.

TABLE 3

Influence of pasteurization on production of tallowiness in butter made May 16–18, 1919, kept at room temperature and at 8° to 10°C.

SAMPLE NO.	CHARACTER OF SAMPLE	TEMPERATURE OF STORAGE	OBSERVATIONS ON BUTTER		
			May 18	June 16	June 24
1A	Raw, check	Room	Slightly sour	Normal	Normal
1B	Raw check	8–10°C.	Slightly sour	Normal	Normal
2A	Pasteurized, check	Room	Normal	Normal	Normal
2B	Pasteurized, check	8–10°C.	Normal	Normal	Normal
3A	Raw + copper	Room	Slightly metallic	Very tallowy, brown	Entirely brown
3B	Raw + copper	8–10°C.	Slightly metallic	About ½ bleached	Almost completely bleached, but no brown color
4A	Pasteurized + copper	Room	Slightly metallic	Very tallowy but not brown	Entirely brown
4B	Pasteurized + copper	8–10°C.	Slightly metallic	Few bleached spots on surface only	Bleaching noticeably on surface
5A	Raw, over-neutralized, + copper	Room	Slightly rancid	Very tallowy, brown	Entirely brown
5B	Raw, over-neutralized, + copper	8–10°C.	Slightly rancid	Slightly bleached on surface	Bleaching noticeably on surface, not so far gone as 4B
6A	Pasteurized, over-neutralized + copper	Room	Off flavor	Slightly tallowy	Very tallowy but not brown
6B	Pasteurized, over-neutralized + copper	8–10°C.	Off flavor	Normal	Normal

samples may represent, therefore, merely the presence or absence of the natural oxidizing enzymes of the butter.

Hunziker and Hosman distinguish between oxidation in butter, which "is strictly a chemical action," and hydrolysis leading to rancidity, which "is accomplished only by the action of ferments." Both reactions, however, are chemical in nature, and according to modern concepts of enzyme activity are merely accelerated or catalyzed by metallic salts in one case, and by the natural "ferments" of the butter in the other case.

The experiments reported in this paper do not throw much light on the question of the agents responsible for the formation of the forerunners of the glycollic acid ester of oleic acid which is believed to produce the tallowy odor and flavor of tallowy butter. The possibility is presented that the metallic compounds instrumental in accelerating the oxidation reactions involved in the decomposition also bring about the hydrolytic changes which must necessarily precede the oxidation.

Whatever may be the chemical changes underlying the tallowy decomposition of butter, the results at least suggest the practical application of high temperature pasteurization in retarding the development of tallowiness in butter which has been contaminated with metallic salts. It is conceivable that cases might arise in which sufficient metallic salts would be present to cause tallowiness in raw cream butter or butter made from cream pasteurized at a temperature too low to inactivate the natural enzymes, but in which the trouble could be avoided entirely by a high temperature of pasteurization.

The influence of temperature of storage on the production of tallowiness is strikingly shown in experiment 3, in which portions of the butter were kept at room temperature and portions at 8° to 10°C., in the refrigerator.

SUMMARY

Tallowy butter was produced by the addition of 0.017 per cent copper lactate to both raw cream and cream which had been pasteurized at 79° to 80°C. In each of three such experiments

typical tallowiness and bleaching occurred in the raw cream butter some time before it appeared in the butter made from the pasteurized cream.

Samples in which over-neutralization of the cream was practised, previous to inoculation with copper-lactate and ripening, failed to show any appreciable acceleration of tallowiness compared with samples not treated with alkali.

The results of the experiments are discussed with reference to the chemical reactions involved in the tallowy decomposition. The view is favored that the natural oxidases of butter aid in producing tallowiness in butter made from raw cream or cream pasteurized at a temperature which does not inactivate the enzymes, rather than that hydrolytic enzymes of butter are essential for the splitting of the neutral fat into glycerol and fatty acid, the oxidation products of which are believed to cause the tallowy odor and flavor. The possibility of the metallic salts acting as hydrolytic enzymes is also suggested.

Authors' note. When the experiments reported in this paper were undertaken they were intended to be preliminary to a more extended study of the chemical factors involved in causing tallowiness. The fact that both of the authors have since left the University of Missouri seemed to make advisable the publication of the preliminary results herewith set forth.

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THE CATALASE CONTENT OF CHEESE

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In a study of cheese of the Emmental or Swiss type we have had occasion to make this kind of cheese from milk treated with hydrogen peroxide. This necessarily entails the proper adjustment of the amount of peroxide used to the hydrogen peroxide-decomposing power of the milk and of such artificial catalysts as may be employed. While engaged in this work the great difference noted in the amount of catalase produced by various types of bacteria suggested that an investigation of the catalase content of different types of cheese might be of interest.

EXPERIMENTAL

The methods employed in this work, as is the case in all determinations of catalase with which we are familiar, were crude and are of value only for comparative tests, though quite satisfactory for that purpose. Five grams of cheese freshly cut from the interior of the mass were finely ground with 25 grams of sand. This material was then put in a large test tube of about 1 inch interior diameter and 25 cc. of 1 per cent neutral hydrogen peroxide added. This was placed in a water bath at 20°C. and the oxygen liberated measured by collection in a water-filled burette. Measurements were taken at five-minute intervals for thirty minutes. This method gave very satisfactory results for comparative purposes but it is recognized of course that the values obtained probably do not represent the actual catalase content of the cheese.

In tables 1, 2, 3 and 4 are given the results obtained from 14 samples of domestic Swiss, 14 samples of Cheddar, 8 samples of pasteurized Cheddar, and 4 samples of imported Swiss cheese. Except in the case of the pasteurized Cheddar cheese, the ages of the samples tested are not known. The Cheddar and domestic

TABLE 1

Catalase content of domestic Swiss cheese

SAMPLE NUMBER	CUBIC CENTIMETERS OF OXYGEN					
	5*	10	15	20	25	30
1	5.3	7.3	8.5	9.4	9.9	10.3
2	15.4	22.6	28.6	32.4	35.4	37.6
3	6.3	8.7	10.2	11.3	12.0	12.5
4	8.6	12.1	14.4	15.9	16.6	17.1
5	5.2	7.4	8.8	9.7	10.4	10.8
6	16.3	22.6	25.9	28.2	29.6	30.5
7	2.3	3.2	3.8	4.4	4.7	4.9
8	11.1	15.4	18.0	19.4	20.4	20.9
9	13.6	18.0	20.6	22.3	23.3	24.1
10	9.1	12.5	14.6	16.0	16.9	17.6
11	11.3	15.0	16.7	17.8	18.5	18.9
12	9.6	14.4	16.5	17.4	17.9	18.1
13	17.8	23.2	25.9	27.8	28.0	28.3
14	1.9	3.0	3.6	4.1	4.5	4.8
Average.....	9.5	13.2	15.5	16.9	17.7	18.3

* Minutes.

TABLE 2

Catalase content of Cheddar cheese

SAMPLE NUMBER	CUBIC CENTIMETERS OF OXYGEN					
	5*	10	15	20	25	30
1	1.6	2.7	3.5	4.1	4.6	4.9
2	2.2	3.5	4.4	5.2	5.8	6.2
3	2.8	4.5	5.6	6.5	7.1	7.5
4	1.9	3.2	4.1	4.6	5.0	5.1
5	2.9	4.7	6.0	6.9	7.1	8.2
6	1.8	2.8	3.4	3.8	3.9	4.0
7	1.4	2.2	2.8	3.1	3.4	3.5
8	0.9	1.5	1.8	2.0	2.1	2.1
9	1.4	2.6	3.4	4.1	4.6	5.0
10	2.6	4.3	5.5	6.5	7.2	7.8
11	1.1	1.8	2.3	2.6	2.9	3.1
12	2.2	3.4	4.4	4.9	5.4	5.8
13	1.2	2.1	2.8	3.4	3.8	4.2
14	1.8	3.0	4.0	4.8	5.3	5.8
Average.....	1.8	3.0	3.9	4.5	4.9	5.2

*Minutes.

Swiss samples were bought on the open market; the four samples of imported Swiss cheese were obtained for experimental purposes through the Department of State; the pasteurized Cheddar cheese were made in these laboratories and were examined when seven months old. The imported Swiss cheese were of the very highest

TABLE 3

Catalase content of pasteurized Cheddar cheese

SAMPLE NUMBER	CUBIC CENTIMETERS OF OXYGEN					
	5*	10	15	20	25	30
1	0.3	0.4	0.5	0.5	0.5	0.6
2	0.3	0.4	0.5	0.5	0.5	0.6
3	0.5	0.8	1.1	1.3	1.4	1.6
4	0.2	0.3	0.4	0.4	0.5	0.5
5	0.4	0.5	0.5	0.5	0.5	0.5
6	0.4	0.5	0.5	0.5	0.5	0.5
7	0.4	0.5	0.6	0.7	0.7	0.8
8	0.3	0.4	0.4	0.5	0.5	0.5
Average.....	0.35	0.5	0.55	0.6	0.65	0.7

*Minutes.

TABLE 4

Catalase content of imported Swiss cheese

SAMPLE NUMBER	CUBIC CENTIMETERS OF OXYGEN					
	5*	10	15	20	25	30
1	14.9	19.8	21.4	22.3	22.9	23.1
2	14.4	19.9	22.9	24.4	25.4	26.0
3	9.5	12.8	14.5	15.4	15.9	16.3
4	14.6	19.5	21.7	22.5	22.9	23.1
Average.....	13.4	18.0	20.1	21.2	21.8	22.1

*Minutes.

quality and showed a striking similarity in all respects. The domestic Swiss samples, on the other hand, showed great variation; a few were of excellent quality, a few were very poor, while the majority were of medium quality.

From these tables it is seen that cheese of the Emmental or Swiss type is richer in catalase than is the Cheddar type of cheese,

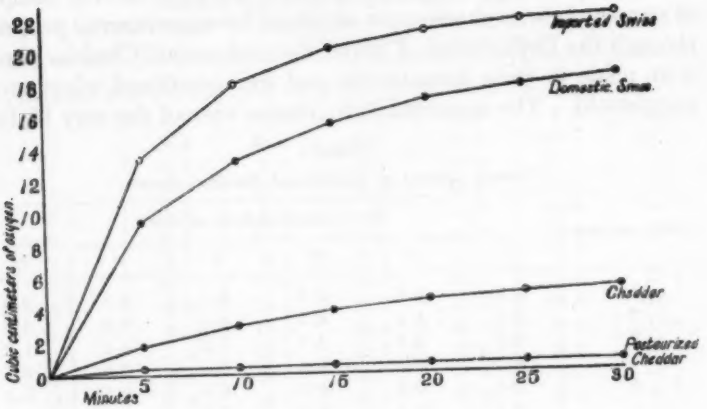
Imported Swiss
Domestic Swiss
Cheddar
Pasteurized Cheddar
Cubic centimeters of oxygen.
Minutes
0
2
4
6
8
10
12
14
16
18
20
22
5
10
15
20
25
30

FIG. 1

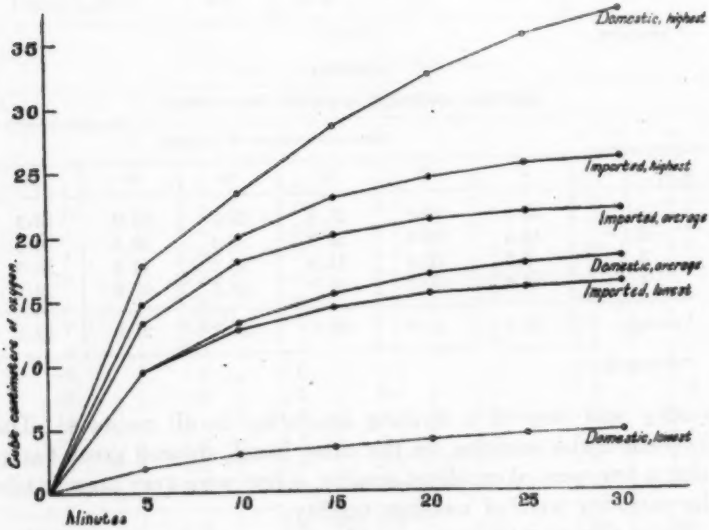
Domestic, highest
Imported, highest
Imported, average
Domestic, average
Imported, lowest
Domestic, lowest
Cubic centimeters of oxygen.
Minutes
0
5
10
15
20
25
30
35
5
10
15
20
25
30

FIG. 2

and that the raw milk Cheddar cheese contains considerably more than does the pasteurized milk cheese. These differences are shown graphically in figure 1 in which are plotted the averages obtained for the various types. Although the average figures obtained show a greater catalase content for the imported than the domestic Swiss cheese, it should be remembered that the four samples of the imported cheese were of selected quality whereas the domestic samples were a miscellaneous lot obtained at random upon the open market. Some of the domestic cheese gave values considerably in excess of those obtained with the imported samples while others gave very low values. In figure 2, in which the highest, lowest and average figures for the imported and domestic Swiss cheese samples are plotted, these variations are shown.

It was naturally suspected that the difference in the catalase content of Swiss and Cheddar cheese is due to a difference in the bacterial flora characteristic of each type. Catalase tests were therefore made of a large number of organisms isolated from Swiss cheese. For these tests the cultures were grown in digested milk for two weeks at 30°C. and then 1 cc. of the culture added to 25 cc. of 1 per cent neutral hydrogen peroxide. Just before adding the peroxide the sample of culture was adjusted to a reaction neutral to phenolsulphonphthalein. In table 5 are given the data obtained from one culture each of the different groups of organisms which have been isolated from Swiss cheese. Through the kindness of Miss Alice C. Evans who furnished the cultures, four organisms which play leading parts in the ripening of Cheddar cheese have also been subjected to this test. These data are given in tables 5 and 6.

These figures suggest that the high catalase content of Emmental cheese may be due to the presence of organisms of the type represented by culture 44.268. That this is probably the case is indicated by data given in table 7 which show the effect of the inoculation of the milk used for cheese making upon the catalase content of the ripened cheese. These cheese were made by the regular factory method of manufacture for the Swiss or

TABLE 5

Catalase production by Swiss cheese bacteria

CULTURE NUMBER	TYPE	CUBIC CENTIMETERS OF OXYGEN					
		5*	10	15	20	25	30
44.71	Group 1	0.0	0.0	0.0	0.0	0.0	0.0
44.87	Group 2	0.0	0.0	0.0	0.0	0.0	0.0
44.103	Group 3	0.0	0.0	0.0	0.0	0.0	0.0
44.246	Group 4	0.0	0.0	0.0	0.0	0.0	0.0
44.268	Group 5	29.1	38.4	43.2	46.0	47.6	48.7
44.280	Group 6	0.0	0.0	0.0	0.0	0.0	0.0
44.293	Group 7	0.0	0.0	0.0	0.0	0.0	0.0

* Minutes.

TABLE 6

Catalase production by Cheddar cheese bacteria

CULTURE NUMBER	TYPE	CUBIC CENTIMETERS OF OXYGEN					
		5*	10	15	20	25	30
2 aq	Strep. lacticus	0.0	0.0	0.0	0.0	0.0	0.0
2 ar	Strep. kefir	0.0	0.0	0.0	0.0	0.0	0.0
2 aa	Strep. "X"	0.3	0.4	0.5	0.5	0.5	0.5
96	Bact. casei	0.0	0.0	0.0	0.0	0.0	0.0

* Minutes.

TABLE 7

Effect of inoculation of milk upon the catalase content of Swiss cheese

CHEESE NUMBER	CUBIC CENTIMETERS OF OXYGEN					
	5*	10	15	20	25	30
1 inoculated	15.4	21.1	23.9	25.6	26.8	27.1
1 check	6.0	8.8	10.1	10.7	11.1	11.2
2 inoculated	12.3	14.9	15.8	16.1	16.3	16.3
2 check	2.2	3.1	3.6	3.8	3.9	4.0
3 inoculated	11.1	13.6	14.5	14.9	15.1	15.1
3 check	3.8	5.3	5.9	6.3	6.5	6.6

Emmental type. The check cheese and the inoculated cheese of the same number were made at the same time from milk which had been thoroughly mixed and divided into two batches just previous to manufacture. One portion of the milk was inoculated

with culture 44.268 and the other left uninoculated for the check. The catalase tests were made when the cheese were four months old.

While we are not as yet prepared to make any statements concerning the identity or the physiological characteristics of this catalase-producing organism, it may be noted, however, that our preliminary results have encouraged us to believe that it will be found to be associated with some of the peculiar properties of Emmental cheese.

SUMMARY

Cheese of the Emmental or Swiss type is in general characterized by a high catalase content as compared with cheese of the Cheddar type. The greater hydrogen peroxide decomposing power of Swiss cheese is due to its characteristic bacterial flora. A high catalase-producing organism which usually occurs in large numbers in Swiss cheese, has been isolated; and inoculation experiments have shown that it increases the catalase content of cheese when added to the milk previous to manufacture.

OCCURRENCE OF THE COLON-AEROGENES GROUP OF ORGANISMS IN RAW AND IN PASTEURIZED MILK, AND ITS SIGNIFICANCE

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INTRODUCTION

The writer has for some time been interested in the problem of the "Occurrence of the colon-aerogenes group of organisms in raw and in pasteurized milk and its significance." Many samples of milk have therefore been examined to determine, if possible, the relation of the above group of organisms to the initial contamination of milk, its age, its temperature, and to the efficiency of pasteurization.

A number of samples have been secured of raw milk produced at the college barn; raw milk retailed in Guelph; raw milk received at the pasteurizing plant of the dairy department of the college; raw milk received at the commercial pasteurizing plant in town (later referred to as Model Dairy) and, finally, of pasteurized milk from the vats of the above two plants. This work covered a full year and has been carried out in four instalments, representing in all the four seasons of the year.

METHODS USED

1. Sampling

In general, the routine methods of analysis were used as described in the "Standard Methods of Bacteriological Analysis of Milk" (2). After thorough agitation of milk 1 ounce samples were secured, using sterile pipettes and bottles. Samples of raw milk sold in town were iced immediately during warm summer weather, taken to the laboratory and plated within two hours after sampling. During the cold weather of spring, fall and winter, no attempt was made to ice the samples since the milk

was already sufficiently cold in most instances and since deliveries of milk were continued for two or three hours after the samples had been taken, so that the bacterial counts obtained really indicated the condition in which milk had been delivered to the consumers. Samples of raw milk received by the pasteurizing plants were taken from the vats after good mixing and were kept in running cold water until collected when the pasteurized milk had been cooled down to 48° to 50°F. and sampled. Night and morning samples at the college barn were taken immediately after milking and kept in running cold water in a tank with the rest of the milk.

2. *Media*

In order to obtain a general quantitative idea of the group counts it was deemed advisable to plate out every sample of milk in this series of experiments on three different media. They were made up as follows:

Litmus lactose agar

	grams
"Difco" peptone per liter of medium	5
"Difco" beef	25
Agar agar	15
Lactose	10

The reaction was adjusted to +0.5, 2 cc. of litmus solution (20 grams per 1000 cc. water) were added per 100 cc. of culture medium, which was put up in flasks of 150 cc. each and finally autoclaved for one-half hour at 15 pounds pressure.

Litmus lactose gelatin

	grams
"Difco" peptone per liter of medium	5
"Difco" beef	25
Gelatin	140
Lactose	10

The reaction was adjusted to +0.5, 2 cc. of litmus solution (20 grams per 1000 cc. water) were added per 100 cc. of culture medium, which was put in flasks of 150 cc. each, and finally sterilized intermittently on three consecutive days.

Aesculin bile salt agar (4)

	grams
Agar agar	12 to 15
Sodium taurocholate	2.5
Witte's peptone were boiled down in 1000 cc. distilled water	10

The solution was neutralized with normal solution of sodium hydrate, cooled below 60°C.; the whites of two eggs or an equivalent quantity of albumen added, the mixture boiled in streaming steam and then filtered through paper. The acidity was then tested and the medium neutralized, if necessary.

One gram of aesculin and 1 gram of iron citrate were then added to the hot mixture. The reaction was again tested and if necessary made to +0.6.

This medium was used to obtain the number of organisms belonging to the B. coli and B. lactis aerogenes groups.

3. Plating

Several samples of milk were secured from the different sources and plated out in a preliminary way to determine the dilutions that would give satisfactory counts. The aim was to obtain agar and gelatin plates having between 30 and 500 colonies per plate, and aesculin plates having between several and 50 colonies per plate. The dilutions had to be varied according to the type of milk and season of the year, so that after a little practice there was no difficulty in getting satisfactory results. The dilutions made for agar and gelatin plates ranged from 1:50 and 1:100 to 1:10,000 and 1:20,000, while those for aesculin plates ranged from 1:10 and 1:100 to 1:5,000 and 1:10,000.

The media in flasks were steamed for one half hour, cooled down and poured into the plates (within one half hour after inoculation) till the melted material covered the plate to the nearly uniform depth of $\frac{1}{8}$ inch. Mixing and uniform distribution were facilitated by a moderate circular movement of the plates. During the warm weather gelatin plates were quickly hardened by being placed on the level top of a box-like tank which had cold water circulating through it. After the material had solidified, the plates (other than gelatin) were inverted and incubated.

4. Incubation and counting

The agar plates were incubated at 37.5°C. for two days and then at room temperature for one day. The aesculin plates were incubated at 37.5°C. for two days, while the gelatin plates at 20°C. for five days. At the end of these respective incubating periods, plates were counted, use being made of a magnifying lens 2½ diameters and a counting plate. The reported figures represent the total count and the various group counts per cubic centimeter of milk.

5. Differential group counts

The differential group counts were obtained in order to get an idea of the proportions in which they were present at different seasons of the year and in different types of milk.

Total count. High counts in market milk indicated, in a general way, carelessness, while low counts indicated care, either in production or in handling, or in both. But bacteriological analyses of individual samples did not furnish enough data for comment. Therefore, in the summary tables that follow, the average of bacterial counts of a specified number of samples of the same type of milk were given, while the analyses of the individual samples were reported in the appendix.

Acid count. This was taken as an indication of initial contamination or subsequent growth, or both. This group included all colonies turning blue litmus red. Most of these were of the harmless lactic acid type, but "standard methods are not such as to give a proper count of lactic acid bacteria" (2). It must be borne in mind, therefore, that the figures reported under this heading are rather an underestimate of the actual conditions.

Liquefied count. This group included all colonies liquefying gelatin, whether rapidly or slowly. These were considered undesirable in milk on account of their putrefactive nature.

Colon-aerogenes count. Under the head of B. coli or colon group, we include all colonies which gave a brown or black coloration on aesculin bile salt agar. We know that this includes many varieties of colon

which have been described by various writers under specific names (e.g., B. communior). It also includes the B. lactis aerogenes group which is found in large numbers in the faeces of cattle. We regard any member of these groups as indicating "manurial impurities" in milk. A large number of this group present in a sample shows either carelessness and uncleanliness in milking, subsequent keeping at a high temperature, or as most frequently happens, a combination of both (4).

In obtaining this group count no attention was paid to lactose fermenting yeasts and to some molds that give the same blackening on aesculin agar. Their colony growth was different from that of the members of colon-aerogenes group.

Other types

Other types not included above, were unimportant and not considered here. They consisted of chromogenic bacteria of little significance in milk and of inert or neutral bacteria producing no acid and having no noticeable effect on milk. According to Conn and Esten (5) these neutral bacteria make up a large percentage of the total bacteria in fresh milk, and a considerable percentage of the total bacteria in old milk, kept at a low temperature.

DISCUSSION

1. Raw milk at the college barn

The college barn is a modern building, well lighted and well ventilated. It is equipped with concrete floors and gutters and is easily kept clean. No particular time or labor-consuming precautions are taken outside of keeping the cows decently clean, milking in a cleanly manner, straining the milk through several thicknesses of cheesecloth which is later washed and boiled, using well-cleaned and steamed utensils and practising immediate cooling of milk by setting the cans in a tank of running cold water.

The average analyses of morning milk, which was three hours old at the time of plating, for the different seasons of the year, are shown in summary table 1.

SUMMARY TABLE 1

(Derived from tables 1 A, B, C)

Raw milk, college dairy barn; morning's milk

SEASON OF THE YEAR	AVERAGE NUMBER OF SAMPLES	TOTAL ON AGAR	ACID ON AGAR	TOTAL ON GELATIN	ACID ON GELATIN	LIQUEFIERS	AESCULIN COUNT	GRADE, MONTREAL, 1914, STANDARD
July, 1917	14	83,000	20,375	96,958	13,363	5,100	707	A—t. B—l; a
Distribution, per cent		100	24.4	100	14	5.3	0.85	
October, 1917	22	35,500	2,585	28,500	2,800	4,350	74	A—t; a. B—l
Distribution, per cent		100	7	100	10	15	0.2	
February, 1918	21	9,600	2,100	11,800	1,400	1,400	49	A—t; l; a
Distribution, per cent		100	22	100	12	12	0.5	
Average per sample per year	57	36,000	7,300	41,300	5,500	2,800	250	A—t; a. B—l
Distribution, per cent		100	20	100	13	7	0.7	

During the summer months there is an indication of bacterial growth having taken place in all of the groups mentioned. This is explained by the fact that ice was not used in the cooling tank, and that the cooling water was not any too cold.

During the other seasons of the year there seems to have been no important change in the relative proportion of the different groups of bacteria, so that the figures given may be taken as a measure of initial contamination at the barn.

Of the average total bacterial content per morning sample at the barn for the entire year it may be said that it was very satisfactory, being below 50,000 per cubic centimeter.

It is of interest to note here that the colon-aerogenes count on aesculin agar during the fall and winter was below 100 per cubic centimeter, presumably indicating the initial contamination under conditions somewhat better than those found on the average farm.

Summary table 2 shows the results obtained with raw night milk produced at the college barn under the same conditions as already indicated, but which was eighteen hours old when plated, and which was kept during this time in running cold water.

The counts of night samples are very much similar to those obtained from the morning samples. They indicate during the summer that bacterial growth has taken place in all of the groups mentioned (but chiefly in the inert group not shown here) to a greater extent than in the morning milk on account of the insufficiently cold cooling water and on account of the longer exposure (eighteen hours as compared to three hours).

The counts of night samples for fall and winter show that there is practically no bacterial increase in any of the groups in milk in eighteen hours, if kept in running cold water.

It may be added that the colon-aerogenes count, too, remains unchanged under this condition of temperature during the fall and winter months.

The averages per night sample for the year are higher than per morning sample, but this is wholly owing to the undue influence of the night samples for the summer.

SUMMARY TABLE 2

(Derived from tables 1 A, B, C)

Raw milk, college dairy barn; night's milk

SEASON OF THE YEAR	AVERAGE NUMBER OF SAMPLES	TOTAL ON AGAR	ACID ON AGAR	TOTAL ON GELATIN	ACID ON GELATIN	LIQUEFIERS	ESCULIN COUNT	GRADE, MONTREAL, 1914, STANDARD
July, 1917	14	276,333	63,250	611,777	40,857	10,115	1,850	B—t; l; a
Distribution, per cent.		100	22.9	100	6.7	1.6	0.67	
October, 1917	22	39,450	1,138	23,300	840	590	60	A—t. B—l; a
Distribution, per cent.		100	3	100	3.5	2.5	0.15	
February, 1918	19	7,000	1,500	14,300	1,500	1,600	110	A—t; l; a
Distribution, per cent.		100	21	100	10	11	1.5	
Averages per sample per year	55	81,800	17,200	151,500	11,900	4,600	595	A—t. B—l; a
Distribution, per cent.		100	21	100	8	3	0.73	

2. Raw milk at consumer's door

Getting a license was the only local regulation affecting the distribution of milk in Guelph. Raw milk at consumer's door was sold either by numerous small milk producers from the immediate vicinity or by many small dealers buying their milk from nearby farms, so that very little of it was more than eighteen hours old and a good deal of it was only six hours old when delivered. Most of the milk was dipped but some of it was bottled the previous night. Hardly any attempt was made to cool the milk properly at any time, particularly in the summer when no ice whatsoever was used and the only protection that the milk received was that of being placed on a covered milk delivery wagon. During the other seasons of the year reliance was placed on the cold weather to keep the milk cool.

Summary table 3 shows the average analyses of the indicated number of samples. The highest total counts were obtained, as would be expected, during the summer, due perhaps to some extent to the pressure of other farm work and the consequent neglect of the proper care of the milk, but chiefly to the failure to cool the milk and to keep it cold.

The lowest total counts were obtained in the fall of the year and may be taken as an indication of the initial contamination at the farm. These figures are in strong contrast with the summer figures and show that even better results may be accomplished by cooling immediately after milking and on purpose.

All differential group counts show that no probable growth of bacteria in the given time took place in the milk in the fall, that some growth took place in the spring, probably before the milk reached the temperature of the surrounding air, and that very vigorous growth took place in milk during the summer.

The total and differential count for the winter (break in the prevailing severe weather came during the time that these samples were taken) shows either increased initial contamination at the farm, a slow growth extending over a longer period (eighteen hours) or both.

As in the preceding table, the average per sample for the year is unduly raised by the high summer count.

SUMMARY TABLE 3

(Derived from tables 2 A, B, C, D)

Raw milk at consumer's door

SEASON OF THE YEAR	AVERAGE NUMBER OF SAMPLES	TOTAL ON AGAR	ACID ON AGAR	TOTAL ON GELATIN	ACID ON GELATIN	LIQUEFIERS	AESCULIN COUNT	AVERAGE TEMPERATURE OF SAMPLES REPORTED	GRADE, MONTREAL, 1914, STANDARD
April, 1917	50	172,312	64,702	126,000	51,409	17,895	1,914	43°F.	B—t; l; a
Distribution, per cent		100	36	100	40	14	1.1		
July, 1917	46	1,803,000	536,238	2,028,484	735,703	90,976	23,254	63°F.	C—t; l. D—a
Distribution, per cent		100	29.4	100	36.2	4.5	1.3		
October, 1917	31	184,000	16,900	127,000	30,300	4,000	588	40°F.	B—t; l; a
Distribution, per cent		100	9	100	24	3	0.3		
February, 1918	29	490,000	234,000	710,000	343,000	17,000	2,100		B—t; l; a
Distribution, per cent		100	48	100	48	2	0.5		
Average per sample per year	156	647,000	175,000	765,000	295,000	43,000	7,600		B—t. C—l; a
Distribution, per cent		100	27	100	38	5.6	1.2		

3. Raw and pasteurized milk from the dairy department of college

The milk at the dairy department was pasteurized every other day, so that in many instances all or some of the milk that reached the pasteurizing vat was forty-eight hours old. The machine in which the operation was carried out was modern in construction and equipped with a heating and cooling coil. The supply of steam for heating the water was abundant. Cooling was effected by the use of water. Pasteurization proper was done by different men at different times, but each one of them had some dairy school training and understood the process.

Summary table 4 gives the average results of bacteriological analyses of raw milk intended for pasteurization. In the spring samples the age of milk is indicated by the total count and the liquefier-count and the insufficiently low temperature is indicated by the acid count. In the summer samples both temperature and age are indicated by the total count and by the different group counts. The high colon-aerogenes count is particularly suggestive of high temperatures.

The winter, fall and spring averages resemble one another except that they grade into one another in the ascending scale in the order mentioned. The explanation for this lies no doubt in the temperature, the other factors, such as initial contamination and age, remaining fairly constant on the whole.

The cause of high average liquefier content for winter milk seems to be that this group is favored by the temperature of the season.

Where milk is to be held any length of time, either in transit or in storage, temperature appears to be more important than the initial contamination.

Summary table 5 shows the results obtained in pasteurized milk. Regardless of the varying quality of the raw milk received from day to day, and of the different persons doing the work, the milk pasteurized at the dairy department had made a uniformly good showing throughout the year, proving the importance of good equipment and understanding of the process on the part of the operator. There is no reason, however, why the raw milk

SUMMARY TABLE 4

(Derived from 3 A, C, E, G)

Efficiency of pasteurization, dairy department, Ontario Agricultural College; raw milk intended for pasteurization

SEASON OF THE YEAR	AVERAGE NUMBER OF SAMPLES	TOTAL ON AGAR	ACID ON AGAR	TOTAL ON GELATIN	ACID ON GELATIN	LIQUEFIERS	AESCULIN COUNT	GRADE, MONTREAL, 1914 STANDARD
May, 1917	10	5,358,000	774,555	6,736,666	878,000	564,000	6,386	D—t; l. C—a
Distribution, per cent.		100	12.6	100	12.9	8.4	0.12	
July and August, 1917	10	22,333,333	9,062,500	20,285,714	11,000,000	444,444	299,500	D—t; l; a
Distribution, per cent.		100	40	100	54	2.2	1.3	
October and November, 1917	12	556,700	62,800	649,200	146,000	32,000	5,070	B—t; a. C—l
Distribution, per cent.		100	11	100	22	5	0.9	
March, 1918	5	258,000	38,000	196,000	42,500	61,000	1,100	B—t; a. C—l
Distribution, per cent.		100	15	100	21	26	0.4	
Average per sample per year	37	7,300,000	2,960,000	8,150,000	4,560,000	340,000	100,000	D—t; l; a
Distribution, per cent.		100	40	100	56	4.2	1.4	

SUMMARY TABLE 5

(Derived from tables 3 B, D, F, H)

Efficiency of pasteurization, dairy department, Ontario Agricultural College; pasteurized milk

SEASON OF THE YEAR	AVERAGE NUMBER OF SAMPLES	TOTAL ON AGAR	ACID ON AGAR	TOTAL ON GELATIN	ACID ON GELATIN	LIQUEFIERS	AESCULIN COUNT	HOW PASTEURIZED	GRADE, MONTREAL, 1914 STANDARD
May, 1917	10	7,266	1,666	2,000	1,120		26	145°F., 20–30 mins.	A
Distribution, per cent		100	23	100	56		0.35		
July and August, 1917	10	11,914	4,150	11,600	3,600	888	77	145°F., 20 mins.	B—t; 1
Distribution, per cent		100	34.8	100	31	7.7	0.7		
October and November, 1917	16	9,100	570	9,900	2,800	315	36	140°F., 30 mins.	A—t; 1
Distribution, per cent		100	6	100	28	3	0.4		
March, 1918	5	2,410	900	4,650	600	460	27	145°F.	A—t; 1
Distribution, per cent		100	37	100	13	10	1		
Average per sample per year	41	8,300	1,600	8,200	2,500	550	42		A—t. B—1
Distribution, per cent		100	19	100	30	6.7	0.5		

Note: The Montreal Standard's requirements for aesculin count in pasteurized milk have not been considered here.

intended for pasteurization should first be allowed to deteriorate in quality.

Pasteurization by the holding process destroyed practically all of the colon-aerogenes group in milk.

Pasteurization by the holding process allowed a good many lactic acid bacteria to remain in the milk and thus to control the subsequent fermentation.

4. Raw and pasteurized milk from the Model Dairy, Guelph

The Model Dairy is the only plant in town that sells pasteurized bottled milk. The plant is equipped with the old type of pasteurizing machine. The operator is an intelligent man who has other duties to attend to and does not always secure uniform results on this account. Some of the farmers deliver their raw milk at the plant, but not daily; other farmers deliver their milk to the man collecting it for the dairy. The milk is pasteurized every morning, is bottled, put away in storage and is delivered the following morning.

Summary table 6 shows the results obtained in the experiments at the Model Dairy. The raw milk throughout the year shows the effects of age and temperature, obliterating entirely the initial contamination.

The milk was at its worst in the summer, with little to choose between the spring and winter milk, and a somewhat improved quality in the fall. Particularly striking is the high seasonal level reached by the colon-aerogenes group in the summer.

Summary table 7 shows the results obtained with pasteurized milk at the same plant. The samples were obtained directly from the pasteurizing vat immediately after the milk had been cooled. Higher counts would undoubtedly be obtained from the same milk at the consumer's door. When the work was started, they were pasteurizing supposedly at 140°F. for thirty minutes. The reduction in bacterial numbers was unsatisfactory—a high total number of bacteria as well as those of the colon-aerogenes group survived the treatment. During the summer and fall, therefore, they were advised to pasteurize at 145°F. for twenty

SUMMARY TABLE 6

(Derived from tables 4 A, C, E, G)

Efficiency of pasteurization, Model Dairy, Guelph; raw milk intended for pasteurization

SEASON OF THE YEAR	AVERAGE NUMBER OF SAMPLES	TOTAL ON AGAR	ACID ON AGAR	TOTAL ON GELATIN	ACID ON GELATIN	LIQUEFIERS	ESCULIN COUNT	GRADE, MONTREAL, 1914 STANDARD
April and May, 1917	19	6,888,421	2,360,555	7,477,333	2,330,714	288,438	50,828	D—t; a; l
Distribution, per cent.		100	34	100	31	3.9	0.74	
July and August, 1917	11	11,975,000	6,887,500	17,037,500	7,431,250	530,000	260,000	D—t; l; a
Distribution, per cent.		100	57	100	44	3	2.2	
October and November, 1917	10	1,931,000	548,750	1,125,700	414,300	126,600	5,000	C—t; a. D—l
Distribution, per cent.		100	28	100	36	11	0.25	
March, 1918	6	4,066,000	2,232,000	6,850,000	2,800,000	400,000	22,500	C—t. D—l; a
Distribution, per cent.		100	55	100	42	5.8	0.55	
Average per sample per year	46	6,290,000	2,900,000	8,345,000	3,220,000	340,000	92,000	D—t; l; a
Distribution, per cent.		100	46	100	38	4	1.5	

SUMMARY TABLE 7

(Derived from tables 4 B, D, F, H)

Efficiency of pasteurization, Model Dairy, Guelph; pasteurized milk

SEASON OF THE YEAR	AVERAGE NUMBER OF SAMPLES	TOTAL ON AGAR	ACID ON AGAR	TOTAL ON GELATIN	ACID ON GELATIN	LIQUEFIERS	AESCULIN COUNT	HOW PASTEURIZED	GRADE, MONTREAL, 1914, STANDARD
April and May, 1917.....	19	214,842	52,789	127,526	47,947	7,526	572	Mostly 140°F., 20-30 mins.	D—t. C—l
Distribution, per cent....		100	24	100	39	6	0.45		
July and August, 1917....	10	37,286	11,050	59,840	25,877	4,450	12	145°F., 20 mins.	B—t; l
Distribution, per cent....		100	29	100	43	7	0.03		
October and November, 1917.....	17	63,900	14,600	79,000	25,000	1,990	46	See table, 4°F.	C—t. B—l
Distribution, per cent....		100	23	100	31	2.5	0.07		
March, 1918.....	7	126,000	82,000	142,000	61,000	1,600	165	140°F., 20-30 mins.	D—t. B—l
Distribution, per cent....		100	66	100	43	1	0.1		
Average per sample per year.....	53	110,500	39,000	102,000	39,000	5,000	324		D—t. B—l
Distribution, per cent....		100	31	100	39	5	0.26		

minutes, and as a result a marked improvement was made, both in the total count and in the colon-aerogenes count.

In the winter, however, the management changed hands and with the intention of saving fuel went back to pasteurizing at 140°F. for twenty to thirty minutes. As a result, the count of bacteria increased again.

These experiments show that the critical temperature for the destruction of the colon-aerogenes group of bacteria is at about 145°F.; that juggling of temperature at pasteurizing plants should be made impossible by the health boards defining the process of proper pasteurization, and that a check should be kept on the efficiency of pasteurization by periodical bacteriological analysis for the sake of protecting the consumers from a false sense of security.

SUGGESTIONS TO THE MEDICAL HEALTH OFFICER OF GUELPH[1]

In view of the results obtained and reported in this study, the following suggestions for improving the milk supply of Guelph seem to be justified.

1. Establishment of a bacterial standard for grading all raw milk sold in the city

Grade A.[2] Total count up to 100,000 per cubic centimeter; colon-aerogenes count up to 500 per cubic centimeter.

Grade B. Total count up to 500,000 per cubic centimeter; colon-aerogenes count up to 5000 per cubic centimeter.

Grade C. Total count over 500,000 per cubic centimeter; colon-aerogenes count up to 5,000 per cubic centimeter.

The above standard practically corresponds with the Montreal 1914 standard.

At least five samples are to be taken from each dealer during four given months of the year representing the different quarters, such as January, April, July and October, and the grades are to be obtained from the average of these samples.

[1] These suggestions are also applicable to other small towns of similar size.

[2] The bacterial counts are to be considered at the time of delivery to the consumer.

2. Temperature requirement

Insistence on having all milk cooled to 50°F. or lower, particularly during the warm weather.

3. Publication in the local press of results of grading for any given quarter of the year

No consumer wants to buy second grade milk, if the price of the first grade is within reach. Grading milk will help the consumer to buy intelligently from a careful dealer. Grading will put a premium on clean milk and would remunerate the producer for the extra effort of producing sanitary milk. Grading will make the careless producer lose his trade or turn over a new leaf.

4. Inspection of dairy farms and dealers' premises

To be carried out by a competent inspector, with a concentration of helpful effort on places and men producing and handling the poorest milk.

5. Control of pasteurizing plants

This would include equipment, process, operators, and results obtained. A bacterial standard for pasteurized bottled milk at the time of delivery to the consumer should be taken as a measure of sanitation and efficiency.

The following grades are suggested:

	RAW MILK FOR PASTEURIZATION		PASTEURIZED MILK	
	Total count per cubic centimeter	Colon-aerogenes count per cubic centimeter	Total count per cubic centimeter	Colon-aerogenes count per cubic centimeter
Grade A.....	Up to 200,000	Up to 500	Up to 10,000	Up to 50
Grade B.....	Up to 1,000,000	Up to 5,000	Up to 50,000	Up to 100
Grade C.....	Over 1,000,000	Over 5,000	Over 50,000	Over 100

In the above standard the total count for raw milk corresponds to the New York Board of Health Standard; the colon-aerogenes count for raw milk practically corresponds to the Montreal 1914 Standard, while the standard for pasteurized milk is original.

6. Pasteurization of all milk by the municipality

This is for the sake of safety and economy, as an alternative to the preceding measures.

This is an ideal plan for a city of the size of Guelph (population of about 20,000). No certified milk is sold in the city at present, but raw milk needed in special cases on doctor's orders could be made available.

The city could operate a model municipal pasteurizing and bottling plant in a new modern building and under expert supervision. It could perhaps be done in connection with the dairy department at the college. This plan would work for the general good of the community from the point of view of safe milk and saving due to the economics of the larger centralized business and consolidation of gathering and distributing routes, together with elimination of wasteful competition, bottle-losses, bad debts, etc.

SUMMARY

1. Ordinary decency in the barn, clean cows and sterile utensils made it possible to produce milk with an initial total count lower than 50,000 per cubic centimeter (summary tables 1 and 2).

2. Immediate cooling of milk to 50°F. or lower checked the increase of the total count of bacteria in general and of the colon-aerogenes group in particular (summary tables 1 and 2).

3. When the temperature of milk was not sufficiently low (50°F. or above) there was evidence of increase at first in all of the groups studied, i.e., the lactic acid bacteria, the liquefiers and the members of the colon-aerogenes group (summary tables 1, July; 2, July; 3; 4; 6).

4. In raw milk initially contaminated at the barn, members of the colon-aerogenes group of bacteria were present only to a small extent averaging less than 100 per cubic centimeter where care was used and 588 per cubic centimeter where varying indifferent methods were used (summary tables 1 and 2, October and February; 3, October).

5. In raw milk having a temperature of 60°F. or higher, a rapid increase in the colon-aerogenes count took place, depending on

the temperature and time allowed for growth, and ranging from 2000 to 300,000 per cubic centimeter (summary tables 3, 4, 6).

6. Fresh cold milk carefully produced contained from 600 to 4000 liquefiers per cubic centimeter.

Milk produced on average farms, indifferently cooled and allowed to age, contained from 30,000 to 500,000 liquefiers per cubic centimeter (summary tables 1, 2, 4, 6).

7. Lactic acid bacteria were present in all milk and increased rapidly at 60°F. or higher (summary tables 3, 4, 6).

8. Proper pasteurization by the holding method destroyed practically all colon-aerogenes organisms per cubic centimeter of milk, leaving an average of 42 per cubic centimeter and showing some samples with 0 per cubic centimeter of milk. The critical temperature for the destruction of these organisms appeared to be about 145°F. (summary tables 5; 7, July, October).

Proper pasteurization caused a great reduction of the liquefying organisms per cubic centimeter, but allowed the surviving lactic acid bacteria to predominate and control the subsequent fermentation, at the ordinary temperature (summary tables 5, 7).

9. Properly pasteurized milk resembles a good quality of raw milk from the bacteriological standpoint, except that it is safer, more uniform, and likely to have a lower content of the colon-aerogenes organisms, fewer liquefiers and is surer to sour normally at ordinary temperatures.

Consumer received greater value for the extra cost (summary tables 1, 2, 5).

Improperly pasteurized milk is not safe, not uniform; has a high total count, a high acid count and a high colon-aerogenes count. In these respects it resembles raw milk of average quality, but costs the consumer more (summary tables 3, 7).

CONCLUSIONS

1. In raw milk initially contaminated at the barn, members of the colon-aerogenes group of bacteria were present only to a small extent, averaging less than 100 per cubic centimeter where care was used, and 588 per cubic centimeter where varying indifferent methods were used.

2. Temperature of 50°F. or lower checked the increase of the colon-aerogenes group of bacteria in raw milk.

3. Temperature of 60°F. or higher resulted in a rapid increase of the colon-aerogenes count in raw milk.

4. Proper pasteurization by the holding method destroyed practically all colon-aerogenes organisms in milk, leaving an average of 42 per cubic centimeter of milk and showing some samples with 0 per cubic centimeter of milk. The critical temperature for the destruction of these organisms appeared to be about 145°F.

5. The colon-aerogenes count in milk obtained on the aesculin bile salt agar immediately after pasteurization becomes a very valuable aid in connection with the agar plate count in controlling the process of pasteurization.

6. A standard for the colon-aerogenes count on aesculin bile salt agar used in connection with the standard total counts should prove of great value in the milk-grading work.

The following standard is suggested:

Proposed standard for grading raw and pasteurized milk

GRADE	RAW. TOTAL COUNT PER CUBIC CENTIMETER ON AGAR	RAW MILK INTENDED FOR PASTEURIZING. TOTAL COUNT PER CUBIC CENTIMETER ON AGAR	PASTEURIZED MILK. TOTAL COUNT PER CUBIC CENTIMETER ON AGAR	RAW MILK. COLON-AEROGENES COUNT PER CUBIC CENTIMETER ON AESCULIN BILE SALT AGAR	PASTEURIZED MILK. COLON-AEROGENES COUNT PER CUBIC CENTIMETER ON AESCULIN BILE SALT AGAR
A	Below 100,000*	Below 200,000*	Below 10,000*	Below 500†	Below 50
B	Below 1,000,000*	Below 1,000,000*	Below 50,000*	Below 5,000†	Below 100
C	Above 1,000,000*	Above 1,000,000*	Above 50,000*	Above 5,000†	Above 100

* Corresponds to the New York Board of Health Standard.

† Corresponds to the Montreal Standard, 1914.

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PEPSIN VERSUS RENNET IN CHEESE MAKING[1]

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Among the many substances that became so very scarce after the beginning of the European war as to seriously affect the very essentials of our life and industry, perhaps none was less generally noticed or more deserving of popular attention, than rennet extract. It is produced entirely from the fourth stomach of calves, which is cleaned, dried or salted and technically called "rennets." In the past, the supply has come very largely from the countries of northern Europe—Denmark has been the chief market for rennets, though the best of the raw material came from Bavaria. The city of Copenhagen, previous to the war, consumed annually about 5,000,000 rennets in the production of rennet extract.

Owing to the war, the importation of the rennets or the extract, gradually failed so that in the spring of 1916, the cheese maker not only was confronted with a shortage of liquid rennet and a tremendous increase in price but the prospects of having to close his factory. When it is realized that the state of Wisconsin alone, produces over 300,000,000 pounds of cheese annually, requiring 100,000 gallons of liquid rennet, the importance of this problem becomes apparent.

In order to obtain the best rennets, only those from milk-fed calves should be used. Hence the calves must be slaughtered before they have eaten solid food and preferably when hungry for about eighteen hours since last fed. Calves shipped on cars are very apt to eat solid food to satisfy their hunger with the result that we get a very inferior rennet. This explains the reason for our unsuccessful efforts in the past to compete with the im-

[1] Read before the Biological Section, American Chemical Society, Cleveland, Ohio, September 12, 1918.

ported product. Professor Pawlow (1) in his work has ably demonstrated that the activity and quantity of the digestive ferments depend upon the composition of the food that is being eaten. If a dog were being fed a diet of meat, the proteid digesting enzymes would predominate in the digestive juices, while if the diets were gradually changed to one of bread, the starch digesting enzymes would predominate.

It has been known for a number of years that pepsin, a substance produced from the mucous membrane of the pig's stomach, would give excellent results in curdling milk for the manufacture of cheese. In fact, according to the Thirtieth Annual Report of the Ontario Agricultural College for 1904 (2) there is no choice in the quality of cheese made with rennet or pepsin as regards yield, flavor, closeness, color, texture and loss of butterfat in whey. The cost of pepsin however, at that time, as well as the conservatism and prejudice of the cheesemaker, barred it from use commercially.

With the advent of the European war and consequent scarcity of rennets, as well as their increased price, pepsin has assumed a very important place in the cheese industry. The cheese maker had been accustomed to measuring out 3 or 4 fluid ounces of liquid rennet for each 1000 pounds of milk and it became necessary to weigh accurately one-quarter of an ounce of dry pepsin for the same work. A great many instances were found where cheese makers were measuring their dry pepsin in a liquid measure. Needless to add, pepsin was blamed for the consequent unhappy results. As a natural sequel, liquid pepsin preparations were immediately introduced and they have proved to be very satisfactory.

The average cheese maker is strongly inclined to follow the same routine he has always known and seldom possesses any scientific comprehension of the processes he employs. It required consequently, a great deal of educational work to convince him that these pepsin preparations of standard strength would give as good results as liquid rennet, if properly used. Just as soon as he experienced any difficulty in his process, it was always the pepsin that was at fault regardless of all other con-

ditions. Several instances to illustrate the educational work required are worthy of mention.

A cheese maker in Wisconsin had been using pepsin with marked success when one day the milk in his vat coagulated unevenly in five minutes instead of evenly in twenty to twenty-five minutes, with a resulting loss in yield and a poor quality of cheese. He immediately found fault with the pepsin and returned to the use of liquid rennet. Upon investigation the following facts were determined:

The cheese maker obtained only slightly improved results the first day he returned to the use of liquid rennet and a continued improvement on subsequent days. There had been a flood covering the pasture land in that vicinity which, on receding, left a deposit of slime and sediment on the grass. After eating this grass the cows produced what is known as a "tainted milk." It was the first day's milk, after the recession of the flood, that coagulated so quickly. Subsequent rains improved the condition of the grass and hence, the quality of the milk. The same trouble would have been experienced regardless of whether liquid rennet or pepsin had been used.

Another cheesemaker, after using pepsin successfully, had a certain batch of milk that required one and one-quarter hours for coagulation. On investigation, it was found that in coagulating separately the milk received from each farmer, one required three and a half hours while the others coagulated in twenty to twenty-five minutes. Further investigation of each cow's milk showed that one required six hours for coagulating. This cow produced what is called by the cheese maker for want of a more scientific term, "sick milk." This, in turn, affected an entire batch of 6000 pounds of milk, resulting in a mushy and sand-like curd.

Most of the complaints against pepsin have been due to the fact that the cheese maker has not observed directions in ripening the milk to the proper acidity. In order to ripen the milk, lactic acid bacteria, which have been added in the form of a lactic acid culture, are allowed to develop under favorable conditions until sufficient acid has been produced to give the milk an acidity of 0.20 per cent.

A very ingenious device is used by most cheese makers to determine the acidity of the milk. It is known as the Marschall Rennet Tester. After the milk in the vat has been heated to 87° to 88° F. about a pint sample is taken in a vessel, the shape of a cup, which has graduations starting about half an inch from the top at 0 and increasing by half divisions to 10 at the bottom. A hole in the bottom of the vessel is fitted with a cork in which is inserted a tube of a very fine bore. When the milk has drained through the little tube until the top is at the 0 mark, 1 cc. of liquid rennet or pepsin, diluted to 20 cc. with water, is stirred in with a spatula. When the milk thickens sufficiently, no more milk will run out and the operator notes the point on the scale to which the milk has run. The riper the milk, the quicker it will coagulate. When the milk coagulates at 2½, its acidity is about 0.20 per cent and ready for the addition of pepsin to the entire batch.

A very important consideration in the manufacture of cheese is the loss of butter-fat in the whey. Conclusions regarding the above cannot be drawn from a single experiment, nor from several, but only as a result of continuous operation employing pepsin. Contrary to Stevenson (3) and Barr (4) and confirming the results of Stewart (5) and Dean (2), our own results have shown after several years' experience that the butter-fat loss is the same with pepsin or rennet.

Three important points to be observed in connection with the use of pepsin are:

1. A good, live starter (lactic acid culture) should be added to the milk.
2. The milk should be heated to 88° F.
3. The acidity should be 0.20 per cent lactic acid before adding the pepsin.

Pepsin does not curdle milk as readily as rennet in the manufacture of sweet curd cheeses such as Swiss, Brick or Limburger. This is due to the fact that sweet curd cheeses are produced from milk of low acidity.

Acid, to a limited extent, accelerates the coagulation with pepsin, while alkali retards or inhibits the action. Where 4 fluid ounces of pepsin have been used to coagulate the milk, 1

fluid ounce might be replaced with hydrochloric acid, which should be added separately in a diluted condition.

There is another startling fact regarding the presence of soluble calcium salts which can be easily demonstrated by laboratory experiments. If the soluble calcium salts present in milk are rendered insoluble by heat or the addition of ammonium oxalate, the milk will not curdle with rennet or pepsin.

The following table will illustrate the effect of the addition of $CaCl_2$ or $CaH.PO_4$ to milk.

	Minutes
Pepsin curdled milk in	30
Adding $\frac{1}{20}$ pound of $CaCl_2$ to 1000 pounds milk, curdled in	30
Adding $\frac{1}{10}$ pound of $CaCl_2$ to 1000 pounds milk, curdled in	17½
Adding $\frac{1}{4}$ pound of $CaCl_2$ to 1000 pounds milk, curdled in	13
Adding $\frac{1}{2}$ pound of $CaCl_2$ to 1000 pounds milk, curdled in	7
Adding $\frac{1}{20}$ pound of $CaHPO_4$ to 1000 pounds milk, curdled in	25
Adding $\frac{1}{10}$ pound of $CaHPO_4$ to 1000 pounds milk, curdled in	18
Adding $\frac{1}{4}$ pound of $CaHPO_4$ to 1000 pounds milk, curdled in	13½
Adding $\frac{1}{2}$ pound of $CaHPO_4$ to 1000 pounds milk, curdled in	9

SUMMARY

Pepsin has replaced rennet almost entirely in the manufacture of cheese, except those of the sweet, curd variety. It is being used in all parts of the world and is much cheaper at present.

Experienced cheese makers have concluded, after several years experience, that the loss of butter-fat in the whey is the same with either enzyme.

Pepsin may be activated by the addition of hydrochloric acid to a limited extent and decidedly activated when used in conjunction with soluble calcium salts.

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OBSERVATIONS ON THE PASTEURIZATION AND SUBSEQUENT HANDLING OF MILK IN CITY MILK PLANTS

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The business of handling and distributing milk in cities has reached a point of considerable importance. It is a business which must be considered as an "essential business" and of equal or greater concern to the general welfare of the community than the questions, food, clothing, housing, water supply and waste disposal.

Importance is placed upon this business because of the fact that milk is an essential food, it is a cheap source of animal protein and fat in a form which is practically 100 per cent digestible. The health of the community may become vitally concerned if the proper attention is not given to the question of safe production and handling of milk.

From the point of view of many health officials, who are apparently well informed on the subject, the pasteurization of all milk has been advocated as a solution of the many dangers that are liable to come from using raw milk.

It has been found, however, that the requirement of pasteurization alone does not solve the problem but that inspection developed to its highest practical degree followed by proper pasteurization brings the best results.

In other words, the pasteurization process was never intended to be used or advocated as a remedy for unclean or slack production under insanitary conditions, but rather to eliminate certain risks which cannot be eliminated in any other way, after the supply has been brought to a point of reasonable safety by inspection and education.

Within the last few years a large proportion of the milk supply in American cities has been sold as pasteurized milk and it seems reasonable to assume that the sale of this milk will continually increase.

The greatest feature of the process of pasteurization, *properly performed*, is that while no valid objections can be raised against the process, it causes an additional degree of safety in milk produced and handled even under the most effective system of inspection.[1]

Doubtless it is the desire of every owner of a pasteurizing device to secure as high a degree of efficiency from the process as is possible and this paper has been prepared for the purpose of reviewing some of the observations that have been made on attempts to perform the process and the subsequent handling of milk.

It must be understood that the mere presence of the pasteurizing apparatus in the milk plant and the running of the milk through such apparatus without special attention to temperature and time and without proper cooling and storage under direct supervision by the manager or some other properly informed person does not secure desired results.

The process will not perform itself nor can it be left to inexperienced help who lack interest, and knowledge of the functions of the process. Pasteurization calls for supervision and control. In most of our cities there is a great lack of this proper control, and supervision by inspectors and health officers.

It may be that inspectors and health officers need to be enlightened as to how to carry on the proper supervision and control in order that they might in turn enlighten some milk plant owner who wishes to do what is proper.

There seems to be a growing tendency on the part of health officials to leave the supervision and control to the pasteurizing plant itself and to measure its efficiency by the bacteria count of the milk when delivered to the public.

The failure of some plants to come within the city requirements for bacteria count is no reason for condemning the process of pasteurization. It is in just such cases where the inspector should step in and help rather than criticize. A little education will often produce marked improvement and the dealer would be able to meet the city regulations.

[1] United States Department of Agriculture Bulletin 342.

This supervision and control of pasteurizing in milk plants can best be accomplished by trained men who have authority to carry on bacteriological control of the process. This control should be based only on accurate data which is current with the existing process. Because health departments have not interested themselves more deeply in this subject of control and assistance we find quite a few milk plants depending on private laboratories established for this purpose. Samples to these laboratories sometimes come from considerable distance and accurate tests are usually not possible. Such results usually tell of the difference between the raw milk entering the plant and the pasteurized milk after it is bottled and the number of samples tested for this information were usually limited to a few.

It seems to be the custom to expect a bacterial reduction of 99 per cent during pasteurization. This may be accomplished in some instances but the efficiency of the process can not be based on the per cent of bacteria destroyed. The condition of the milk when it is actually used is essential.

Often 99 per cent of the bacteria may be destroyed and yet the milk may still contain hundreds of thousands while in other cases in which it contains only tens of thousands the per cent of reduction may have been only 80 to 90.[2]

Because of the fact that not all of the bacteria are destroyed by pasteurizing the milk is therefore not sterile, it is still a perishable product and it must be handled, stored and used with the same precautions as raw milk. This point is too often lost sight of by all who have to do with pasteurized milk and for the protection of all concerned the proper labeling of the container with the date of pasteurization has proved to be best in increasing trade and satisfying consumers.

Pasteurization adds expense and from a strictly business point of view it is difficult to understand why, after the process has been properly performed, any manager will allow the results to become void because of some subsequent operation which causes inoculation of the milk.

[2] United States Department of Agriculture Bulletin 342.

TABLE 1

Pasteurization tests

DATE	RAW			HEATED			HELD			COOLED			BOTTLED	
	Place received	Temperature	Count	Place	Temperature	Count	Time	Temperature	Count	Place	Temperature	Count	Temperature	Count
							minutes							
June 6	Vat	71.0°	682,000	Holder	143.0°	83,000	30	145°	2,000	Bottler	60°	1,000	63°	13,600
June 8	Vat	72.0°	942,000	Holder	143.0°	105,000	30	144°	4,600	Bottler	60°	3,860	66°	11,400
June 8	Vat	72.0°	975,000	Holder	143.0°	86,000	30	144°	6,000	Bottler	60°	2,400	64°	9,600
June 13	Vat	72.0°	145,000	Holder	142.0°	30,000	30	144°	1,070	Bottler	48°	1,040	60°	2,000
June 13	Vat	72.0°	265,000	Holder	142.0°	30,000	30	144°	2,600	Bottler	48°	1,540	56°	3,000
June 15	Vat	70.0°	572,000	Holder	142.0°	71,000	30	143°	4,200	Bottler	50°	3,500	58°	2,800
								143°	3,700	Bottler	50°	4,400	58°	2,300
June 18	Vat	68.0°	381,000	Holder	142.0°	39,100	30	144°	500	Bottler	59°	300	54°	800
June 18	Vat	68.0°	278,000	Holder	142.0°	41,400	30	144°	500	Bottler	59°	300	54°	800
		70.6°	530,000		142.4°	60,700		144°	3,146		56°	2,038	59°	5,744
										Reduction 99 per cent			Reduction 99.6 per cent	

It is likewise difficult to understand just why the milk is allowed to pass through the pasteurizating apparatus under no supervision or control expecting the apparatus to do the work by itself.

Cases which illustrate these points are not difficult to find. It is not because there is anything at fault with the process of pasteurization as it should be done but rather that the process has merely been attempted and in reality no favorable results have been obtained.

To illustrate an instance where inoculation has occurred after the process has been performed and where the milk has not been properly cooled the preceding table is given showing actual tests at a large milk plant.

It will be noted that the reduction in bacteria count after the milk is cooled is 99.6 per cent and that it is 99 per cent after it is bottled. Without further comment such a reduction would seem to indicate that the pasteurizating was being done very efficiently but let us study the facts closer.

Having gained a reduction of 99.6 per cent it would seem to have been the best policy to have maintained that degree, but this was not done. The loss of 0.6 per cent does not seem to be significant but in reality it means that the average bacteria count was increased from 2038 to 5144 or 152 per cent during the bottling process.

The temperature of the milk increased from 56 per cent to 59 per cent during this process which shows that there was but little if any attempt to maintain the degree of reduction gained by the process itself.

An examination of the empty cans and bottles at this milk plant showed them to be practically sterile and the conclusion was drawn that the bottling machine constituted the source of inoculation after the cooling and prior to the bottling. This was confirmed when sterile water was run through the valves in a bottling machine and bacteria counts made on the water thus collected with the following results:

	Bacteria count of water
Valve 1	336,000,000
Valve 2	126,000,000
Valve 3	216,000,000
Valve 4	165,000,000
Average	210,750,000

The estimate inoculation per 1 cc. of milk when 10 gallons are in the bottling machine would be

Valve 1	8400
Valve 2	3150
Valve 3	5400
Valve 4	4125
Average	5269

With these facts known it is not difficult to understand why there occurred an increase in bacteria count after milk passed through the bottling machine.

The following table illustrates another instance when the milk was allowed to pass through unsterilized apparatus after the heating and holding for thirty minutes at temperatures varying from 136°F. to 148° or an average of 140°F. This instance shows what usually happens when there is an absence of temperature record control.

The table shows that while a reduction of 97.8 per cent has been secured by the heating process there is an increase in bacteria count of 6 per cent after the milk has passed over the cooler, of 30 per cent more from cooler to bottler, of 33.5 per cent more from bottler to the bottle and of 335.7 per cent more after the milk has been stored for 24 hours before delivery.

From after the heating process until the milk was bottled there was an increase in bacteria count of 84.6 per cent.

The total increase in bacteria count from after the heating process until the milk was delivered was 704.2 per cent.

After the milk had been cooled the temperature was allowed to rise 8°F. Assuming that 300 gallons of milk passed over the cooler and afterwards the temperature increased 8° the loss in terms of ice at 15 cents per hundredweight would be 120 pounds

TABLE 2

DAYS	AVERAGES OF SAMPLES	RAW MILK		HELD			COOLED				BOTTLED		STORED 24 HOURS	
							Off cooler		Into bottler					
		Temperature	Count	Time	Temperature	Count	Temperature	Count	Temperature	Count	Temperature	Count	Temperature	Count
				min.										
14	210	73°	970,000	30	140°	20,475	44°	21,750	47°	28,305	52°	37,800	52°	164,710
				Reduction 97.8 per cent			Reduction 97.7 per cent		Reduction 97 per cent		Reduction 96.1 per cent		Reduction 83.2 per cent	

	TEMPERATURE	BACTERIA COUNT	PER CENT BACTERIA INCREASE
Average increase off cooler		1,275	6.0
Average increase cooler to bottler	3°	6,555	30.0
Average increase bottler to bottle	5°	9,495	33.5
Average increase bottled to 24 hours old		126,910	335.7
Total increase pasteurizer to bottle	8°	17,325	84.6
Total increase pasteurizer to delivery	8°	144,235	704.2

or 18 cents for the entire amount or $\frac{3}{4}$ pounds per gallon. This represents actual loss and when multiplied by the repetition of the same process for the fourteen days under observation the loss becomes $2.52. This would be further increased with the frequency of the process.

At another milk plant observations were made on the holding of milk after it had been heated, the holding temperature varying from 85° to 130° for thirty minutes according to the temperature of water in the water jacket surrounding the holding compartments.

The tests were made while the milk was being run through the pasteurizing apparatus by inexperienced men and it clearly shows the necessity of supervision and control of the process. The milk was cooled in the usual way but no attention was given to the temperature at which the milk was held for thirty minutes.

The table shows that after heating raw milk, having a bacteria count of 31,575 and holding it for thirty minutes at 85° there was an increase of 5.7 per cent in the bacteria count. This milk was passed over a cooler, it being the first milk over and the bacteria count was increased 346 per cent above the count of the raw milk.

Heating the raw milk and holding it at 100° F. for thirty minutes resulted in an increase in bacteria count of 39.4 per cent and after it was stored at 44° for twenty-four hours the increase in bacteria count over the raw milk was 789 per cent.

Heating the raw milk and holding it at 110° for thirty minutes resulted in a 42.2 per cent reduction in bacteria count but when stored for twenty-four hours at 44°F. there was an increase of 654 per cent over the original count of the raw milk.

Heating the raw milk and holding it at 115° for thirty minutes resulted in a 59 per cent reduction in bacteria count but after storing at 44° for twenty-four hours there was an increase of 454 per cent over the original count of the raw milk.

Heating the raw milk and holding it at 130°F. for thirty minutes resulted in a 70.2 per cent reduction but after storing for twenty-four hours at 44° there was an increase of 527 per cent over the bacteria count of the raw milk.

TABLE 3

Special tests showing heating and holding milk at different temperatures and cooling in the usual way under actual commercial

TABLE 3

Special tests showing heating and holding milk at different temperatures and cooling in the usual way under actual commercial conditions

RAW MILK				HEATED			COOLED		BOTTLE OR CAN			STORED 24 HOURS		
Before clarifying		After clarifying		Temperature	Time	Count	Temperature	Count	Place	Temperature	Count	Place	Temperature	Count
Temperature	Count	Temperature	Count		*minutes*									
								1st over						
42.0°	33,000	90	35,300	85°	30	33,400	40°	142,000						
42.0°	42,000	90	32,000				40°	140,000						
40.0°	24,000	110	29,600											
40.0°		110	29,400	5.7 per cent increase			346 per cent increase							
				100°	30	33,700	40°	31,300	Pint	48°	32,500	Pint	44°	265,000
				100°	30	54,400	40°	31,300	Pint	48°	36,200	Pint	44°	297,000
				39.4 per cent increase			8 per cent reduction					789 per cent increase		
				110°	30	19,400	40°	24,600	Pint	48°	32,200	Pint	44°	162,000
				110°	30	17,000	40°		Pint	49°	43,200	Pint	44°	314,000
				42.2 per cent reduction			22.1 per cent reduction		19.4 per cent increase			654 per cent increase		
				115°	30	13,100	38°	17,200	Pint	48°	31,200	Pint	44°	175,000
				115°	30	12,600								
				59 per cent reduction			45.5 per cent reduction		1.2 per cent reduction			454 per cent increase		
				130°	30	9,400	38°	12,000	Pint	50°	38,200	Pint	44°	198,000
				130°	30	9,400								
41.6°	33,000	100	31,575	70.2 per cent reduction			62 per cent reduction		21 per cent increase			527 per cent increase		

The conclusions that can be drawn from these tests are convincing and they prove that the process of pasteurization must not be left to novices but rather to experienced operators who have knowledge of the objects of the process and the correct way to secure and maintain results.

At this same plant a series of tests were made when the heating process was under control but inoculation from some source occurred after the heating.

Inoculation of milk after it has been pasteurized is one of the most important problems of the present day milk problem. It has been pointed out that the failure to properly wash and sterilize milk cans causes them to become a serious source of contamination.[3]

CONTAMINATION OF MILK CANS

Supplementing these studies the writer has conducted similar tests at twenty-one milk plants located in different sections of the country. These studies however were concerned with freshly washed cans which were to be filled with pasteurized milk for the trade. To determine the initial inoculation which would be given to milk placed in the cans the same technic was employed, namely: rinsing the can with 200 to 500 cc. of sterile water, drawing off some of the rinse water from each can and making a bacteriological examination of it. By running high dilutions on the sample of rinse water the total bacteria count of the can may be computed. The result is then divided by the capacity of the can in cubic centimeters, the final result being the estimated initial inoculation given by the can to 1 cc. of milk.

This will be the initial inoculation of bacteria which will develop under favorable conditions either in the milk or in the can itself.

It is therefore important to reduce this initial inoculation to the minimum. In the examination of 236 milk cans under all conditions of washing and steaming the initial inoculation when ready for filling was found to vary between zero and 7,920,000

[3] Observations on the washing of milk cans. R. O. Webster and R. S. Smith, (*Int. Assn. of Dairy & Milk Inspectors*, Report 1917, pp. 54-56.)

TABLE 4

DAYS	AVERAGE OF SAMPLES	RAW MILK				HEATED			COOLED		BOTTLE OR CAN		STORED 24 HOURS	
		Before clarifying		After clarifying										
		Temperature	Count	Temperature	Count	Temperature	Time	Count	Temperature	Count	Temperature	Count	Temperature	Count
							minutes							
5	128	45.7°	54,074	84°	152,375	145°	30	6,240	45.2°	8,452	51°	15,592	42.2°	24,386
						96 per cent reduction			94.4 per cent reduction		89.7 per cent reduction		85 per cent reduction	

	TEMPERATURE	BACTERIA COUNT	PER CENT BACTERIA INCREASE
Increase off cooler		2,212	35.4
Increase cooler to bottler	5.8°	7,140	83.4
Bottled to 24 hours old	Decreased 8.8°	8,894	57.0
Total increase pasteurizer to bottle	5.8°	9,352	149.8
Total increase pasteurizer to delivery	Decreased 3°	18,146	290.8

bacteria. The following table shows to some extent why can washing in different pasteurizing plants plays an important rôle in the condition of the milk after it has been pasteurized, it being understood that initial inoculation is noted and not the growth in the milk as the result of the initial inoculation of bacteria.

Typical results of examination of freshly washed milk cans from different plants

Different plants and varied conditions:	Average
Initial bacterial inoculation of 30 cans varied from 30.0 to 162....	82.0
Initial bacterial inoculation of 4 cans varied from 23.0 to 945....	264.0
Initial bacterial inoculation of 10 cans varied from 2.0 to 120....	42.6
Initial bacterial inoculation of 3 cans varied from 1.0 to 48....	17.6
Initial bacterial inoculation of 29 cans varied from 37.0 to 2250....	684.0
Initial bacterial inoculation of 10 cans varied from 2.7 to 100....	38.2
Initial bacterial inoculation of 10 cans varied from 18.0 to 16....	5.2
Initial bacterial inoculation of 24 cans varied from 1.1 to 75....	41.0
Initial bacterial inoculation of 25 cans varied from 0.2 to 562....	52.8
Initial bacterial inoculation of 6 cans varied from 60.0 to 360....	168.3
Initial bacterial inoculation of 19 cans varied from 12.0 to 840....	207.0
One plant:	
Cans placed over steam jet, 10 cans varied from 52 to 675.....	206.6
After new can steamer was installed, 9 cans varied from 1.5 to 441	97.3
Difference of 53 per cent due to new steamer.	
One plant:	
Clean water and steam jet and drainage, 5 cans varied from 80 to 2.750.....	1010.0
Two other days, 13 cans varied from 500,000–7,920,000 (gas in 100 per cent of tests)	2,277,900
Dirty water and steam jet no drainage, 6 cans varied 1,200,000–5,490,000 (gas in 50 per cent of tests).	

It is interesting to note that gas formers were found to be present in the drain water from all of the 13 cans examined at one plant on one day and in 3 of the six cans examined on the other day and that the presence of gas formers in the milk from this plant was in part attributed to this source.

Too much emphasis cannot be given to the fact that only thorough washing, steaming and drying produces a sterile container for milk and that milk should not be allowed in any other than a sterile container at any time, and particularly if the milk has been pasteurized or otherwise heated. Voiding of the process of pasteurization by introducing inoculating factors is poor policy. Not only is the object of the process defeated and the

time and cost of operation lost but the condition of the milk may become an actual menace to the health of the community.

EXAMINATION OF MILK BOTTLES

The washing and sterilizing of returned empty milk bottles to a city milk plant constitutes a big problem. Bottles are received in varying conditions of cleanliness and from the many and varied sources of collection and it becomes somewhat of an accomplishment to make them sterile containers for milk.

Under varying conditions of washing and steaming at different milk plants the initial inoculation which would be given to the milk by the empty bottle was found to vary from zero to 1636 bacteria per cubic centimeter. A total of 268 empty bottles have been examined by rinsing with 20 to 30 cc. of sterile water and then making a bacteriological determination of the rinse water and dividing the result by the capacity of the bottle in cubic centimeters.

Typical results of examination of empty milk bottles

(Bottles were ready to be filled with milk)

			Average
Initial inoculation of	16 pint	bottles varied from 0.3 to 1008...	23.9
	5 pint	bottles varied from 4.1 to 126...	52.1
	4 pint	bottles varied from 32.0 to 57...	44.4
	45 pint	bottles varied from 0.0 to 900...	72.3
	6 pint	bottles varied from 2.0 to 36...	13.6
	10 pint	bottles varied from 61.0 to 1408...	392.2
	10 pint	bottles varied from 33.0 to 1130...	236.0
Tests at same plant	12 quart	bottles varied from 26.0 to 1636...	482.2
	22 pint	bottles varied from 28.0 to 245...	89.5
Tests at same plant	12 pint	bottles varied from 55.0 to 228...	141.0
	10 quart	bottles varied from 25.0 to 143...	82.0

While the inoculation may be deemed small in some instances it must be emphasized that the tests show the initial inoculation which would be present and which would develop rapidly under favorable conditions in the milk.

It is interesting to note the difference in the result of the different milk plants and in the difference in results on pint and quart bottles in the same plants. The amount of drain water in 22 bottles in one plant taken at random from bottles

stored without inverting in cases showed a range of from 1 cc. to 6.2 cc. with an average of 2.8 cc. Such bottles stored in a warm room and having drainage present to act as an inoculating agent are hardly suitable final containers for milk especially if the milk has been pasteurized.

The inoculation from the empty bottle can be reduced to a minimum by thorough washing, steaming and draining and as this is possible and highly important from a health point of view no other method should be tolerated.

Placing pasteurized milk in a bottle which has not been sterilized just previously lessens the efficiency of the pasteurized process and helps to defeat its purposes.

EXAMINATION OF MILK BOTTLE CAPS

In the examination of 2166 milk bottle caps in batches of from 28 to 68 taken from the caps in use at different pasteurizing plants the initial inoculation per cubic centimeter of milk from the cap was found to range from zero to 453. The surface in contact with the milk is limited to the under side of the cap.

The bacteriological examination of batches of caps washed with sterile water in the laboratory showed a high total count present in some instances but when divided by the number of caps and by one-half the cap surface the inoculation to 1 cc. of milk became small.

Typical results in the examination of milk bottle caps

		Average
Initial bacterial inoculation of	206 bottle caps varied from 0.01 to 4	1.2
	33 bottle caps showed no inoculation	
	28 bottle caps showed no inoculation	
	41 bottle caps showed no inoculation	
	45 bottle caps showed no inoculation	
	68 bottle caps showed no inoculation	
	33 bottle caps showed no inoculation	
	35 bottle caps showed no inoculation	
	207 bottle caps varied from 2.3 to 12.8	3.8
	84 bottle caps varied from 20.0 to 453.0	5.6

A special study was made at one pasteurizing plant on different days to see if any difference existed between the use of loose

advertising bottle caps and the caps used in tubes as they are received.

Advertising caps

(Furnished by a local shoe repairing company and used on bottles of pasteurized milk)

		Average
Initial inoculation of	50 bottle caps	3.3
	70 bottle caps	6.4
	80 bottle caps	1.2
	56 bottle capr	2.2
	52 bottle caps	1.7
	34 bottle caps	1.9
	52 bottle caps	3.5
	394	3.6

Bottle caps in closed tubes

Initial inoculation of	52 bottle caps	0.9
	62 bottle caps	0.08
	48 bottle caps	0.2
	40 bottle caps	0.1
	40 bottle caps	0.1
	58 bottle caps	0.1
	40 bottle caps	0.8
	340	0.4

These tests show that the advertising caps furnished by the shoe repairing company in bulk in open boxes had an initial inoculation of 88.8 per cent greater than the caps in sealed tubes. The fact that the bulk caps had to be nested for use in the capping machine caused a handling that is avoided when tube caps are used.

While the initial inoculation from milk bottle caps may be small the importance of handling and of storage of the caps especially in bulk lots should not be overlooked. Often we find the caps being inserted by hand, a practice that should not be tolerated. While it may not be possible to measure the result by bacteriological examination the danger from possible typhoid carriers should serve as a warning against the practice and the necessity for the utmost precautions.

CONCLUSIONS

The process of pasteurization of milk as it is carried on in many city milk plants should receive more detailed attention.

In many instances only an attempt at the process is being made. This being due to either lack of attention or to the absence of understanding on the part of the operators as to the functions and reasons for the process.

Although the process causes a reduction of bacteria the per cent of the reduction is not a measure of the efficiency of the process.

If the milk becomes reinfected after the heating and holding process the intent of the process becomes void. Time and temperature control of the process together with bacteriological tests at different stages and afterwards is necessary if a safe product is to result.

City health officials should not rest assured of a safe product because of the mere presence of a pasteurizing plant in their city. Special attention must be given to the operation of such a plant in view of the fact that it is a chance source of infection of any sort to the entire community.

The operation of pasteurizing plants where the indiscriminate heating and handling is carried on as a remedy for poor milk condition under the guise of pasteurizing should be checked.

Permits for the sale of "pasteurized milk" issued by the health department only to such plants as have complete pasteurizing equipment with recording devices and where subsequent handling methods insure a safe product to the consumer will be a step in advance toward the present problem.

Bacteriological control of the process and of the condition of the subsequent containers and contact surfaces is essential, this examination should not be left to the pasteurizing plant but should be made frequently by competent officials under the direction of the health officials responsible for the health of the community. Employees whose duties bring them into contact with the milk after it has been pasteurized either directly or indirectly by contact with surfaces likely to be reached by the milk, should be medically examined frequently. All such persons

should be given the prophylactic preventative treatment now given by the army and navy.

The inoculation of pasteurized milk from improperly washed cans constitutes a problem that has been neglected. Only when a can is properly washed, steamed and dried should it be considered as a sterile and proper container for pasteurized milk.

The inoculation of pasteurized milk from improperly washed bottles makes it possible for the milk plant to become a disseminator of infection from many sources under the protection of the term pasteurized milk.

Only when bottles are properly washed, steamed and stored should they be considered as containers for pasteurized milk.

The inoculation of pasteurized milk from milk bottle caps is necessarily small because of the limited contact surface but nevertheless hand capping and the use of caps in bulk lots, especially those bearing advertising not related to the milk business and which are promiscuously stored and handled should not be tolerated.

The utmost precaution in the process of pasteurization of milk at proper temperature for the proper time and the elimination of the chances of reinfection or inoculation of the milk from persons and surfaces after the process has been properly performed constitute a vital and ever increasing problem.

It is hoped that some facts have been brought to the attention of owners and operators of pasteurizing plants that will cause them to realize their responsibility. It is also hoped that health officials and milk inspectors may also realize the extent of this current and future problem and that control and enlightenment are essential.

THE NECESSITY OF TAKING A COMPOSITE SAMPLE OF MILK WHEN GRADING RAW MILK BY NUMERICAL BACTERIAL CONTENT

ROY S. DEARSTYNE[1] AND LLOYD R. JONES

The decided fluctuations in the bacterial counts of individual milk producers hauling milk to pasteurizing plants, caused the writer to investigate the factors causing such unusual fluctuations, and to endeavor to arrive at a fair method of sampling and grading such product.

In order to secure the data listed below, the samples were taken at the plant of the product milked the previous evening and subject to the different methods of storage as listed in the table, and of the product secured at the morning milking which lacked the twelve hours or so of storage, and was brought to the plant before the germicidal action had ceased, or at least before any decided increase could take place on account of temperature. Temperatures were taken on these samples as delivered, and agar plate counts were run according to the technique of Standard Methods, American Public Health Association.

An attempt was made to correlate the counts with the mean daily temperature secured from the local United States Weather Bureau Station observations, methods of storage, length of haul, and temperature of delivery of product.

The results of these observations are tabulated on opposite page.

From these tabulations, it can be seen that the range of differences of the morning and evening product as delivered at the dairy is great. The high temperatures of the morning product as delivered at the plant were undoubtedly due to negligence on the part of the producer in cooling his product—a fault which is readily corrected by using proper cooling methods.

As can be seen from the tabulation listed above, nearly all types of storage methods were used, and the superiority of the vat method shows up readily. It is interesting to note how

1919	MEAN TEMPERATURE OF DAY	BACTERIAL COUNT OF PREVIOUS EVENING'S MILK	TEMPERATURE DELIVERED AT PLANT	BACTERIAL COUNT OF MORNING'S MILK	TEMPERATURE DELIVERED AT PLANT	PER CENT HIGHER		AVERAGE MEAN TEMPERATURE OF DAYS	AVERAGE PER CENT HIGHER	STORAGE CONDITIONS
Dealer "A"										
May 28	81	80,000		14,000		Eve.	470			10 gallon cans set in tubs of water—water not renewed—5 mile haul over good roads in machine
June 4	74	10,000	78	2,000	74	Eve.	400			
June 17	69	4,000,000	68	6,000	82	Eve.	66,566			
June 25	78	2,400,000	74	10,000	81	Eve.	23,900			
July 5	83	200,000	73	70,000	86	Eve.	186	77	18,304	
Dealer "B"										
June 4	74	52,000	70	20,000	79	Eve.	160			10 gallon cans set in tubs of water—water not renewed—5 mile haul over good roads in machine
June 17	69	1,800,000	70	11,000	82	Eve.	16,232			
June 25	78	75,000	74	45,000	80	Eve.	67			
June 28	74	40,000	73	7,000	81	Eve.	471			
September 10		65,000	64	10,000	79	Eve.	550	74	3,496	
Dealer "C"										
May 27	82	1,200,000		55,000		Eve.	2,080			Concrete vat—not insulated—water not renewed—4 mile haul over good roads in wagon
June 10	76	750,000	70	36,000	87	Eve.	1,983			
June 14	76	320,000	69	35,000	85	Eve.	810			
June 18	74	3,000,000	61	100,000	83	Eve.	2,900			
June 21	64	6,300,000	64	640,000	83	Eve.	880			
July 5	83	600,000	79	60,000	84	Eve.	900			
July 11	74	360,000	64	200,000	84	Eve.	80			
July 19	72	800,000	68	75,000	88	Eve.	970	75	1,325	

1919	MEAN TEMPERATURE OF DAY	BACTERIAL COUNT OF PREVIOUS EVENING'S MILK	TEMPERATURE DELIVERED AT PLANT	BACTERIAL COUNT OF MORNING'S MILK	TEMPERATURE DELIVERED AT PLANT	PER CENT HIGHER		AVERAGE MEAN TEMPERATURE OF DAYS	AVERAGE PER CENT HIGHER	STORAGE CONDITIONS
Dealer "D"										
May 27	82	3,000,000		70,000		Eve.	4,190			Stored in large box with ice—dealer indifferent—4 mile haul over poor roads in machine
June 10	76	750,000	70	36,000	87	Eve.	1,980			
June 14	76	320,000	69	35,000	85	Eve.	810			
June 18	74	3,000,000	61	100,000	85	Eve.	2,900			
June 21	64	6,300,000	64	640,000	82	Eve.	880			
July 5	83	600,000	79	60,000	84	Eve.	900			
July 11	74	360,000	64	200,000	84	Eve.	80			
July 19	72	800,000	68	25,000	82	Eve.	3,100	75	1,855	
Dealer "E"										
June 10	76	550,000	76	70,000	84	Eve.	690			10 gallon cans set in spring overnight—good flow of water—4 mile haul over poor roads with team
June 18	74	800,000	73	420,000	82	Eve.	90			
June 21	64	1,900,000	64	240,000	80	Eve.	690			
June 28	74	50,000	66	160,000	82	Morn.	220			
July 15	83	300,000	73	55,000	82	Eve.	440			
July 19	74	50,000	64	20,000	73	Eve.	150			
	72	350,000	69	50,000	82	Eve.	600			
		500,000	66	15,000	82	Eve.	3,230	74	764	

					"Dealer F"					
June 14	76	80,000	67	10,000	87	Eve.	700			Insulated concrete vat—water renewed—careful dairymen—3 mile haul over good roads in wagon
June 18	74	300,000	68	80,000	86	Eve.	270			
June 21	64	110,000	68	12,000	84	Eve.	820			
July 11	74	100,000	68	20,000	82	Eve.	400			
July 19	72	150,000	73	11,000	88	Eve.	1,260			
September 10	72	23,000	62	10,000	84	Eve.	130	72	596	
					Dealer "G"					
June 14	76	2,400,000	68	17,000	85	Eve.	14,020			Concrete vat—not insulated—no renewal of water. Indifferent producer—5 mile haul over good roads in machine
June 18	74	1,600,000	68	100,000	84	Eve.	1,500			
June 21	64	3,600,000	70	58,000	83	Eve.	6,110			
July 5	83	600,000	73	45,000	88	Eve.	1,230			
July 11	74	400,000	68	350,000	81	Eve.	13			
July 19	72	500,000	73	100,000	84	Eve.	400			
September 10		200,000	66	60,000	82	Eve.	230	74	3,357	
					Dealer "H"					
June 3	76	1,800,000	86	44,000	79	Eve.	3,990			Concrete vat—not insulated—careful producer—5 mile haul over good roads in machine
June 14	76	800,000	72	37,000	85	Eve.	2,062			
June 18	74	1,300,000	71	100,000	84	Eve.	1,200			
June 28	74	200,000	71	20,000	72	Eve.	9,000			
July 19	72	350,000	72	35,000	86	Eve.	900	74	3,430	

much less the increase in count of the product of dealer "F" is in comparison with the other dealers. As indicated, this producer had an insulated vat and renewed his water supply at least once. As would be expected, the increase in count of the dealers storing their product in tubs of water was much greater than the other types used, while the uninsulated concrete vats in which no renewal of water was made, ranged high. The natural method of storing and efficiency of running spring water is very desirable where such facilities are available.

Although we would not attempt to draw conclusions from the data tabulated, it is interesting to note that in comparison of average per cent of increase by dealers and the average mean temperature for each dealer's series of observations there is an analogy in the case of dealer "A" having the highest average per cent of increase, the average mean temperature was the highest. Conversely as in the case of dealer "F" with the lowest average per cent of increase there was noted the lowest average mean daily temperature.

To the writers' certain knowledge, it is the practice of inspectors in many cities collecting raw milk samples, to secure them from any can bearing the mark of a desired producer, as is also the case in collecting original packages from dealers in raw milk where only one delivery is made a day. Under these conditions of collection there are probably many counts reported which are not a true index of the producer's sanitary precautions, and a consistent collection of the night's milk of one dealer might well prove disastrous to the rating of his product on the market.

INFORMATION RELATIVE TO DAIRY MANUFACTURES COURSES AND STUDENTS TAKING THEM IN THIRTY-ONE DAIRY DEPARTMENTS OF AGRICULTURAL COLLEGES IN THE UNITED STATES

W. P. B. LOCKWOOD

Amherst, Massachusetts

During the fall and winter of 1918-1919, through his work in connection with the DeLaval Separator Company the writer was afforded the privilege of visiting thirty-two dairy departments in the agricultural colleges of the United States and one in Canada.

The writer was interested in the organization of the departments, volume of business done, sources of supply and disposal of products, courses offered, teaching, equipment, and number of students taking dairy handling and manufactures work. Having been connected with the Extension Service the writer was interested in the Farmers' Weeks and Farmers' Days attendance and methods of getting the farmers to the colleges.

The dairy departments were working along lines that would best take care of the dairy needs of their respective states, in so far as their funds would permit. In a large number of instances they were working at a disadvantage for lack of funds.

The organization of the departments is along three general lines:

1. What dairying is given is given by the animal husbandry department.

2. Dairy departments having charge of both production and handling and manufactures.

3. Dairy departments having only handling and manufactures.

In some departments the dairy extension men were connected directly with the department and in others they were not.

One or two of the teaching departments were not connected with the experiment stations.

In one case manufactures were included under the animal husbandry department: the college department teaching four-

year students; the extension department and experiment station running the college creamery, and the head of the department having nothing to say as to extension or experiment station dairy work.

The amount of business done in different dairy departments varied from the handling of the milk from the college herd in some institutions to $123,000 per year in one manufacturing department. Local conditions relative to supply, markets and college restrictions were the governing factors. Some departments were selling college herd milk wholesale or retail and buying milk and cream for laboratory work; and one department was running a coöperative creamery in connection with the college work.

The courses in manufactures varied from four or five lectures in Babcock testing, handling separators and buttermaking to extended courses of these and other manufactures subjects. With one or two exceptions this was governed largely by the importance of dairying in the agriculture of each state.

The teaching, or subject matter, presented in the different institutions varied. Some departments present essentially fundamentals giving laboratories to illustrate, while others give both fundamentals and detail in both lecture and laboratory work. Some institutions had no definite detailed outlines worked out for courses offered. This was brought out very plainly when one instructor went to an institution as head of the department he found no outlines whatever, and had to ask the students what they had been given in the courses they had taken.

At one institution a department makes it a practice of requiring that every course shall be outlined very specifically and fully as to subject matter. Each member of the department goes over all outlines, and these are discussed in department meetings thus giving the course the benefit of the discussion. It was found that this procedure reduced the repetition of work in the department, as well as improving the courses. As the teacher gives his work he notes any changes to be made in the course for another year, and these changes are made immediately after the close of the course work in order that they may not be over-

looked or forgotten. This has the decided advantage of having the work done and ready for the next year and keeps the work up to date.

The equipment for teaching dairy manufactures was as good, if not better in two agricultural schools in New York State than in several of the agricultural colleges. In one state practically all funds used for teaching agriculture, aside from teachers' salaries, had to come from the sale of products from the college and experiment station farm.

As no compiled data seemed to be available as to the number of students taking dairy work in the agricultural colleges it seemed that a good opportunity was open to secure it. The following form was finally adopted for convenience in working out and tabulating. Regular courses in production and Babcock testing were not included.

Courses for:

A. Four year students.
   1. Required—Elementary dairying or farm dairying.
   2. Elective farm dairying.
   3. Buttermaking.
   4. Advanced buttermaking.
   5. Market milk.
   6. Ice cream making.
   7. Cheese making (cheddar and soft cheeses) or either separate.

B. One, two or three year students.
   1. Farm dairying.
   2. Buttermaking.
   3. Market milk.
   4. Ice cream making.
   5. Cheese making (same as under four year).

C. Winter course students (varying from six to twelve weeks).
   1. Farm dairying.
   2. Buttermaking.
   3. Market milk.
   4. Ice cream making.
   5. Cheese making (same as under four year).

D. Women farm dairying.

E. Special dairy course students (including two weeks courses, special dairy courses for home economic classes, etc.).

F. Summer school students.

While gathering the other information it seemed worth while to find out the number of people going to the colleges for Farmers' Weeks and Farmers' Days. All information gathered was based on pre-war conditions. See attached tabulation:

Dairy manufacture courses for four year students

17 colleges required elementary or farm dairying.
9 colleges offered elective courses in farm dairying.
18 colleges offered separate courses in buttermaking.
4 colleges offered separate courses in advanced buttermaking.
9 colleges offered buttermaking combined with other courses.
13 colleges offered separate courses in market milk.
3 colleges offered courses in market milk and ice cream combined.
11 colleges offered separate courses in ice cream making.
3 colleges offered courses in ice cream and cheese making combined.
14 colleges offered separate courses in cheese making.
6 colleges offered general manufacturers courses.

Courses for one, two or three year students

18 colleges offered courses in farm dairying.
11 colleges offered no courses in farm dairying.
4 colleges offered courses in buttermaking.
1 college offered courses in ice cream making.
4 colleges offered courses in cheese making.
6 colleges offered courses in general manufactures.
24 colleges offered no courses in manufactures.

Winter course students

15 colleges offered courses in farm dairying.
16 colleges offered courses in manufactures.
5 colleges offered separate courses in buttermaking.
2 colleges offered separate courses in market milk.
3 colleges offered separate courses in cheese making.
13 colleges offered no courses in manufactures.

Other courses

4 colleges offered special courses for women.
8 colleges offered special dairy courses of one to two weeks duration.
14 colleges offered special dairy courses in summer schools.

Changes have been made in the work in several of the institutions this year. Some of them that gave general manufactures courses are splitting up these courses into courses on specific subjects. One institution has added a two-year course that will require a course of elementary dairying in which it will have 180 students.

Student statistics

		per cent of total
Students taking all courses:		
4654	Four year	53.28
1082	One, two, or three year	12.38
2264	Winter	25.92
734	Special summer, etc	8.42
8734		

Students taking farm dairy courses:

2677	Elementary or farm dairy required 57.5 per cent of four year students.
331	Elective farm dairy, four years.
730	Farm dairy, one, two, or three years.
1183	Winter.
4921	Total, or 56.34 per cent of total students.

		per cent of total
Students taking manufactures courses:		
1646	Four year	53.43
352	One, two or three year	11.39
1081	Winter	35.18
3079	Total, or 43.66 per cent of total students.	

The number of students is reduced to the basis of one student per one term or semester, per course, not considering the number of hours per week or credits.

One striking feature is that 57.5 per cent of the four year students are required to take a course in elementary or farm dairying, and that 56.34 per cent of the total students taking courses in the manufactures department are elementary or farm dairying students.

What is back of this? A study of the tabulations show that all of the states requiring these courses are dairy products producing. Is this significant to the other states producing dairy products? There is great difference in the way this course is taught in the different institutions. Naturally one man stresses some points and another others. It would make quite an interesting study to take notes or outlines of these courses and compare them.

It is doubtful if we have realized the condition as it exists. When asked what text do you use, the usual answer was "there

is none that covers all the phases we want to touch so we prepare lectures, and refer to Wings' *Milk and Its Products, etc.*"

Every student taking this course has been a user of milk and if he raises a family will be again if he is not now, whether he was raised in the country or town or city. It would seem that this is where some of our best teachers should be used and some of our best teaching done.

It is a question as to whether or not the Dairy Departments as a whole are not trying to do too much work with the material that they have. In some departments men were teaching too many hours, or combining too much teaching, experiment station, extension or administration work to be able to keep up with the necessary reading and improvements so essential to good work. It is like squeezing a sponge, everything going out and little or nothing being absorbed or taken in.

Farmers' Weeks and Days

27 colleges held Farmers' Weeks.
5 colleges held Farmers' Days.
1 college held neither Farmers' Weeks nor Days.

The attendance at Farmers' Weeks in 26 colleges was 39,650, and for Farmers' Days, in 5 colleges 26,000, or a total of 65,650.

The large attendance at Farmers' Days, at Pennsylvania and Mississippi is accounted for by excursions being organized at different times, the number given being the total for a number of days. At Mississippi each county agent organizes an excursion, in all thirty counties are organized. They have an average attendance of 400 per day or excursion.

The writer feels that with the material so far gone over, and which this report represents, it would be well worth while to make a survey, possibly annually, to keep track of what is going on in all of the colleges. If this work is undertaken it should be done systematically on a well worked out plan.

COLLEGE	FOUR YEAR STUDENTS							1, 2 or 3 YEAR STUDENTS					WINTER COURSE STU			
	REQUIRED-SECONDARY OR FARM DAIRYING	ELECTIVE FARM DAIRYING	BUTTERMAKING	ADVANCED BUTTER-MAKING	MARKET MILK	ICE CREAM MAKING	CHEESE MAKING	FARM DAIRYING	BUTTERMAKING	MARKET MILK	ICE CREAM MAKING	CHEESE MAKING	FARM DAIRYING	BUTTERMAKING	MARKET MILK	
MAINE			11		11								7			
NEW HAMPSHIRE		25						60					15			
VERMONT				20											35	
MASSACHUSETTS		7	40		20	15									35	
CONNECTICUT	[a] 45		12		10	18		35							20	
RHODE ISLAND		16		4				10								
NEW YORK CORNELL			110	30	160	50	50						18	100	100	
MICHIGAN	[a] 150		35		35	15	15	75							40	
OHIO		125	25		12	15	20	70	6			4	100	30		
PENNSYLVANIA	[a] 230		16	13		16	?	90	13		11	?	90	30		
NEW JERSEY	[b] 25				10										150	
DELAWARE		15														
MARYLAND		60						16					50			
VIRGINIA			15		15		15	40					10	7		
KENTUCKY		40						10					40			
TENNESSEE	[b] 50		2			1	1						20			
NORTH CAROLINA	[b] 100			12				20				5	20			
SOUTH CAROLINA	[c] 40				18					12						
MISSISSIPPI	[a] 225		12			10		50							9	
ALABAMA				[c] 35				10								
GEORGIA				75				30								
NORTH DAKOTA		5	3		3	3	3	9					45			
SOUTH DAKOTA	[a] 50		10		10		10	50							15	
MINNESOTA	[a] 150		10			30		75						20		
WISCONSIN	[a] 278		15		10		10	40	2	1		1	300		159	
NEBRASKA	[a] 100		25		7	16	10	40		25			175		14	
IOWA	[a] 380		102	24	40	22	46		272					127		
ILLINOIS	[a] 375	38	35	11	18	12	8									
INDIANA	[b] 200		12		12	12	12								16	
KANSAS	[b] 140		12		12	12							200		12	
MISSOURI	[b] 89			39	26		5						93		10	
TOTALS	2677	331	1646					730	352				1183	1061		

	1,2 or 3 YEAR STUDENTS					WINTER COURSE STUDENTS								
CHEESE MAKING	FARM DAIRYING	BUTTERMAKING	MARKET MILK	ICE CREAM MAKING	CHEESE MAKING	FARM DAIRYING	BUTTERMAKING	MARKET MILK	ICE CREAM MAKING	CHEESE MAKING	WOMEN FARM DAIRYING	SPECIAL DAIRY COURSES	SUMMER SCHOOL DAIRY COURSES	TOTAL STUDENTS
						7								29
	60					15								100
								35						55
								35					8	125
	35							20			25			165
	10													30
50						18	100	100		100				718
15	75							40				25	15	415
20	70	6			4	100	30		30					437
?	90	13		11	?	90	30			?			7	516
								150						185
													25	40
	16					50							30	156
15	40					10	7			12			5	119
	10					40								90
1						20							1	75
	20				5	20							100	257
			12										8	118
	50							9				16		322
	10											20		65
	30											6		111
3	9					45								71
10	50							15				25		170
	75						20				65	31	40	421
10	40	2	1		1	300		159				70		896
10	40		25			175		14			20	10	10	452
46		272					127						149	1162
8														497
12								16						264
						200		12			12		6	406
5						93		10					5	267
	730	352				1183	1081				122	203	409	8734

TOTAL STUDENTS	FARMERS' WEEK ATTENDANCE	FARMERS' DAYS ATTENDANCE
29	150	
100	300	3000
55		
125	600	
165	2000	
30	500	
718	3500	
415	1000	
437	4000	
516	900	6000
185	2000	
40		3000
156		2000
119	500	
90	600	
75	1500	
257	1200	
118	?	
322		12000
65	1000	
111	1500	
71	2000	
170	200	
421	1600	
896	2000	
452	3000	
1162	3000	
497	2500	
264	400	
406	1200	
267	2500	
8734	39650	26000

OPEN FORUM

A Score Card for City Ice Cream Plants

The output of the ice cream industry has greatly increased in the last decade and likewise its commercial value. We now recognize it as one of the many American industries. But while the output and value have greatly increased, the sanitary measures have not kept pace with the industry. In some places possibly they have kept pace and in others they have not. One thing is certain that on the whole the ice cream industry has not received as much attention from a sanitary point of view as some of its sister industries. For example, in most cities we do not find any bacteriological standard for ice cream or the constituents that go into its make up. We do not have a score card for city ice cream plants as we do for city milk plants. Cities in which there is a system of country and city milk inspection, we find no provision for inspection of ice cream plants or the farms supplying the cream and milk for ice cream. Many cities realizing the great need of sanitary inspection are taking steps to provide for this inspection.

It was while working for the Detroit Board of Health at Detroit, Michigan, in the summer of 1917 in the capacity of a sanitary inspector for ice cream plants, that my attention was called to the need of two things: First, regular sanitary inspection of all places large or small manufacturing ice cream, and second, a systematic way of recording the inspection.

Inquiry was then made of the Bureau of Animal Industry as to whether they knew of a score card for ice cream plants and they replied that they had never issued such a score card and knew of none, unless, the Louisiana State Board of Health issued one. Upon writing to them and having them forward a copy of their score card it was found that it was not a score card at all but simply a memorandum card upon which the inspector made general notations of the sanitary condition of the place, but it was a step in the right direction, however, and a great improvement upon no score card.

I am sure that no one familiar with the situation would doubt the need of regular sanitary inspection by a competent inspector. Here we have a plant manufacturing a product which is easily contaminated, and quite frequently is being handled by employees who are ignorant of the dangers that they may introduce by their ignorance and carelessness.

Now if this product were fed to cattle or utilized in any other way than it is, our problem would cease to exist; but since it is included in the human diet and occupies such a prominent place, it certainly needs careful sanitary supervision and inspection. Ice cream is not only used quite extensively in the normal healthy human diet, but is often recommended by physicians for the young, the old, and convalescents alike. The same physician who would hesitate to recommend anything but certified milk (or some milk equally dependable) with a bacteria count of 10,000 or less, does not hesitate to recommend ice cream with no bacteria standard whatever, but which usually ranges from 10,000 to 1,000,000,000 bacteria per cubic centimeter.

The fact that ice cream is frozen seems to cover a multitude of sins in the layman's mind. Just as the farmer and most other people believe that straining and clarifying make dirty milk clean, likewise people believe that freezing kills all bacteria. All of these facts argue very strongly for regular sanitary inspection.

The duties of an inspector of ice cream plants, as in the case of any other sanitary inspector, are many. If he educates one man one way, advises another in another way, and assists the others in other ways, the sum total of his labors are varied and his efforts result in confusion. The best way to help all and secure uniform results is by the score card. In this way there is an outline to guide him and he can accord to all the same help and treatment.

The score card for ice cream plants as it is arranged here follows in general outline the score cards for city milk plants as approved by the United States Department of Agriculture, but is arranged to meet the needs of city ice cream plants. The ice cream plant is scored on the basis of 100 per cent as perfect, 40 per cent for equipment and 60 per cent for methods.

The sanitary location of the building is the first consideration. Next comes the arrangement of the building providing a separate room for each major operation. The construction of the rooms and other sanitary considerations as drainage, light, pure air, screens, etc., are next taken up. The apparatus necessary for keeping the machinery and utensils clean and sanitary, also the apparatus for handling ice cream in a sanitary way, together with the condition of the machinery are given consideration. Laboratory and equipment are also taken into account as well as the water supply.

The sanitary methods are considered from the viewpoint of the cleanliness of the building such as floors, walls, etc. The cleanliness and protection from contamination of the apparatus used in making,

handling and storing the ice cream both before and after making are given consideration. The way in which the constituents used in making the ice cream are received, protected and cared for before they are used for ice cream is given a very prominent place. The score card makes it possible for the man who goes to the trouble and expense of installing a pasteurizer to get a better score than the man who does not. There are many arguments pro and con in regard to pasteurization of the constituents of ice cream but there certainly is no question as to the ultimate outcome of the matter. The time is not far distant when all cities shall require the constituents of ice cream to be pasteurized. A place is given to the wrapping of brick ice cream which is often wrapped in a very unsanitary way. Storage and protection during delivery are likewise given a place. The bacteriological analysis of both raw materials and the finished product as well as the inspection of the dairies supplying cream are included under the head of inspection. This should help to produce a purer product. Then under "miscellaneous" comes the cleanliness of attendants and provision for medical inspection thus helping to decrease the possibility of pathogenic organisms in the final product after all other precautions have been taken. Finally, comes the sanitary outfit to carry a sanitary product to its destination, provided all the other provisions in the score card have been lived up to.

The score card follows:

BOARD OF HEALTH

SANITARY INSPECTION OF CITY ICE CREAM PLANTS

SCORE CARD

Owner or manager.....
Street and No.....
City.....State.....
Trade name.....
Number of wagons.....Gallons sold daily { Bulk ice cream..... / Brick ice cream.....
Permit or License No.....
Date of inspection.....191
Remarks.....
.....
.....
.....
.....
.....
.....
.....Inspector.

Arranged by F. W. Fabian, Michigan Agricultural College, Department of Bacteriology and Hygiene, East Lansing, Michigan.

EQUIPMENT		SCORE	
		Perfect	Allowed
Building:			
Location:			
Sanitary surroundings		2	.....
Arrangement			
Separate receiving room	1		
Separate freezing room	2		
Separate mixing room	2		
Separate wash room	1		
Separate sales room	1		
Separate boiler room	1		
Separate refrigerator room	1		
Construction			.....
Floors, tight, sound, cleanable	2		
Walls, tight, smooth, cleanable	1		
Ceilings, smooth, tight, cleanable	1		
Drainage	2		
Floors	1		
Sewer or septic tank	1		
Provision for light	2		
(10 per cent of floor space)			.....
Provision for pure air	2		
Screens (windows, doors)	1		
Minimum of shafting, pulleys, hangers, exposed pipes, etc	1		
Apparatus		13	
Boiler	2		
(Water heater, 1)			
Appliances for cleansing utensils and cans	1		.....
Sterilizers for cans, etc	2		
Wrapping machine (brick ice cream)	2		
Clean table for hand wrapping	1		
Wash bowl, soap, and towel in handling room	1		
Condition	4		
Ice cream freezing and mixing machinery	2		
Pipes, couplings, and pumps	1		
Cans and containers	1		
Laboratory and equipment	2		
Water supply		2	.....
Clean and fresh	1		
Convenient and abundant	1		
Total		40	.....

F. W. FABIAN.

College of Agriculture, Michigan.

The Need for Additional Training

It would seem that the various departments have a splendid opportunity made for them in regard to the training of competent operators and managers of various dairy plants. This need has been a growing one here in the East in general and in Vermont in particular. There are a great many plants that have not made the success which was due them on account of not being able to secure a competent operator and manager. The reason has perhaps been partly due to the fact that various institutions have not been willing to offer inducements for such men as may be desirable. However, at the present time, there is a tendency of those various plants to be willing to pay competent men salaries which would prove attractive, but there seem to be no men available.

Why could not the various dairy departments make a special inducement for the training of such men? That is, I mean, schedule a course which would give proper attention to the marketing phase of the work. It is really pathetic, in a great many instances, to see how poorly the various operators are prepared to dispose of the products from their plants where anything but ordinary commission trade is carried on. That business, of course, requires no skill, except being able to fill out properly a bill of lading, but when it comes to disposing of the product, partly by individual methods of shipment through the means of the parcel post and express shipments, then they are not so well informed. Neither are they having the proper understanding of how to solicit individual trade and make proper calculations in regard to the cost of manufacturing the various grades of products and putting them up for shipment in larger or smaller packages as the case may be. This need has not been so apparent in the West, where, as stated, most of the shipments have gone to the commission men, but here in the East a large, and in fact, a very large share of the business is done directly with the individual consumer, retailers, wholesalers and the like.

Moreover, it is necessary, in order to meet competition successfully, that various kinds of dairy products be manufactured during the different seasons of the year, and it is here that many of the operators meet with difficulties on account of their shortcomings in training and lack of understanding in regard to the market requirements. While, as I stated, the western states have not been up against those conditions so much in the past, there is no question but that they are coming to it in the near future, and it is well to be prepared. If for no other reason,

show how to take care of the home market, which has been sadly neglected but which offers splendid opportunities for development.

Another place where the creamery operators and managers are lacking in preparation is in regard to the accounting system. In too many places by far, this is overlooked or carried on in a way which is not either economical or efficient. If you could, as I have had opportunity to do, see the difficulty with which a great many dairy organizations have met during the past year or two in regard to furnishing the information which the government required in order to carry on the war successfully, you would entirely agree with me. I believe that the various dairy institutions could very well afford to spend a little more time and money in regard to the business end of the dairy industry. The students should be more acquainted with the markets and I do not feel that it would be asking too much that the dairy graduates, before receiving their diplomas, should have been acquainted with the markets in one of the large business centers most conveniently located to the institution which they attend.

I am mindful of the fact that a number of the dairy schools are planning and making preparations to give this information and instruction, and am only bringing up the question with a hope that it may lead to a discussion in regard to how such work can best be carried on.

I trust that these suggestions may be taken in the spirit in which they are offered, namely, for the purpose of making the dairy industry live up to its opportunities and reach the position to which it is entitled.

M. R. TOLSTRUP.

Montpelier, Vermont.

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